MEDINFO 98
B. Cesnik et al. (Eds)
Amsterdam: IOS Press

Telemedicine and Medical Informatics in the Multimedia Super Corridor: The Malaysian Vision

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Abstract

The practice of medicine, with its wide range of environmental conditions and complex dependencies, has long been used as a test bed for various advanced technologies. Telemedicine, as conceptualised within the Multimedia Super Corridor (MSC) context, is seen as the application of several relatively mature technologiesartificial intelligence (AI), multimedia communication and information systems (IS) amongst othersso as to benefit a large cross-section of the Malaysian population. We will discuss in general terms the Malaysian vision on the comprehensive MSC telemedicine solution, its functionality and associated operational conditions. In particular, this paper focuses on the conceptualisation of one key telemedical component i.e. the Lifetime Health Plan (LHP) system, which is eventually intended to be a distributed multi-module application for the periodic monitoring and generation of health-care advisories for upwards of 20 million Malaysians.

Keywords

Multimedia Super Corridor; Lifetime Health Planner; Tele-Health, Telemedicine, Medical Informatics

Introduction

The Multimedia Supercorridor (MSC) [1] is a large-scale infrastructure and services project initiated by the Malaysian government. Its geographical location will be in a rectangular area bracketed by the Kuala Lumpur City Centre (KLCC) to the north and the new Kuala Lumpur International Airport (KLIA) to the south, with high-speed Wide Area Network (WAN) connectivity. The MSC will also feature advanced logistical facilities and physical infrastructure including a pair of intelligent garden citiesi.e. Putrajaya and Cyberjaya, respectively the future administrative and commercial hubs.

MSCs growth will, in the initial stages, be focused along the lines of several ambitious application-layer flagship projects [1] earmarked for rapid development and eventual nation-wide deployment. These projects will explore conceptual and implementation models as regards the application of Information Technology (IT) on a societal basis, spearheading the post-industrial transformation of Malaysia and serving as a global test bed for innovative solutions. The areas targeted for intensive development are (1) Electronic Government, (2) Multi-purpose Card, (3) Smart Schools, (4) Telemedicine, (5) Research and Development (R&D) Clusters, (6) World-wide Manufacturing Webs and (7) Borderless Marketing.

Telemedicine within the MSC

Health maintenance and illness prevention, needless to say, play a crucial role not only to an individuals quality of life but also to societal well-being. The primary objective of MSC-based telemedicine is to establish a healthcare system leveraging advanced information and multimedia technologies to deliver a hitherto unattainable services at the individual, family and community-level. For maximum utility, such services must be accessible from the home, or at least from within the users immediate community; a feature made practical by the MSCs high-bandwidth multimedia environment. In addition, the unavoidably complex systemin recognition of the realities inherent in contemporary healthcaremust be perceived to be as seamless as possible, while being custom-tailored to the needs of all parties involved i.e. the individual, community, healthcare professionals and associated service providers (such as insurance firms) amongst others.

The most innovative feature of MSC telemedicine is its broad definition and all-encompassing scope beyond the traditional point-to-point data exchange model useful primarily to healthcare professionals in well-equipped urban hospitals and laboratories. The MSC telemedicine initiative is meant to articulate a user-centred and wellness-focused system able to inform and empower individuals with regards to consistently maintaining the highest state of health throughout a lifetime. Hence, the label telehealth is perhaps a more appropriate description of MSC telemedicine as pointed out by no less than the Health Minister. The above-mentioned characteristics are very much in line with the national healthcare vision statement [1], ie:-

Malaysia is to be a nation of healthy individuals, families and communities; through a health system that is equitable, affordable, efficient, technologically appropriate, environmentally adaptable and consumer friendly; with the emphasis on quality, innovation, health promotion and respect for individual and community participation towards an enhanced quality of life.

The MSC telemedicine model was designed to encompass four key pilot projects i.e. (1) Customised/Personalised Health Information and Education, (2) Continuing Medical Education, (3) Teleconsultation and (4) Lifetime Health Plan (LHP). The first two are essentially informational and educational services respectively targeted at the general public [2] and the healthcare community [3], with major advancements anticipated in terms of delivery system technology. Teleconsultation [4] covers multimedia connectivity between healthcare service providers with the objective of enhancing and extending basic work processes. The remainder of this paper specifically concentrates on fleshing out the LHP component. Figure 1 [5], illustrates the entire scope, together with functional interactions between the four pilot projects, of the MSC telemedicine project.

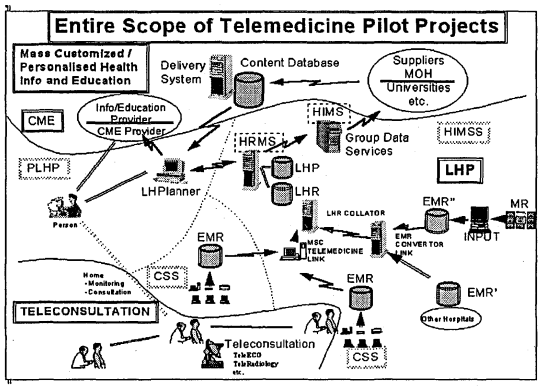

Figure 1 - Scope of MSC Telemedicine

The top of Figure 1 shows the Mass Customised/ Personalised Information and Education (Info/Edu) and Continuing Medical Education (CME) projects. The bottom part of Figure 1 shows the Teleconsultation pilot project. The middle part of Figure 1 gives an alternative but equivalent view of the LHP project, showing the LHP project interfacing with the Info/Edu and Teleconsultation projects.

Conceptual Model of LHP Systems

The LHP is probably the most unique and yet complex of all the pilot project areas. Key features in any successful LHP system would be an individual-centred implementation and also continuity between episodic contacts with healthcare service providers. This very much depends on the existence and controlled availability of medical records compiled over an individuals lifespani.e. the Lifetime Health Record (LHR)which can then be used to formulate integrated and personalised health plan. Accumulation of such data on a nation-wide scale would be a major endeavour, but would also encourage development in innovative applications to mine the raw data. Such knowledge extraction system would not only benefit practitioners and healthcare providers, but ultimately individual users and society as a whole.

The need for transformation of patient data into an electronic format is driven by the necessity of obtaining an individuals medical history during initial contact with a medical professional. This process often consumes a substantial portion of the practitioners time, especially during episodic encounters with patients possessing a potentially complex case history. New information must also be recorded and integrated in a organised manner before an appropriate diagnosis can be attained and treatment administered. Ensuring the availability, accuracy and completeness of medical records would therefore be of great value to medical professionals. Data comprehensiveness should progress not merely chronologically within a single healthcare facility, but should also extend across different institutions. Such a seamless temporal record of an individuals health would enable individualised proactive medical planning, thereby resulting in continuous and consistent womb-to-tomb healthcare independent of geographical location, specific healthcare providers and other environmental conditions. All of these elements are central to the design of the Personalised Lifetime Health Plan (PLHP)..

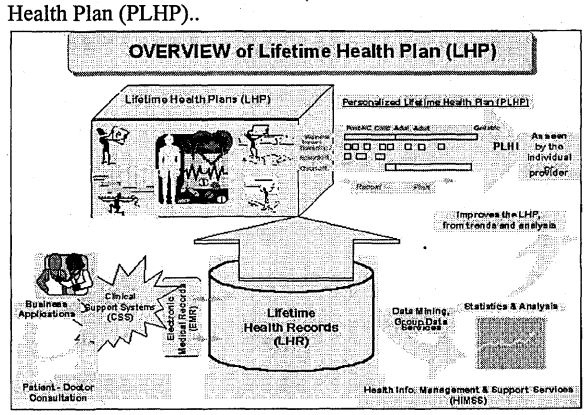

Figure 2 - LHP Overview

In summary, LHP is the healthcare infrastructure with which to deliver the LHRs and PLHPs directly to individuals or alternatively via primary healthcare providers or general physicians. A large-scale implementation of the LHP would necessitate the design and implementation of IT-based mechanisms for the nation-wide acquisition and storage of the pertinent biomedical records. The LHP project can therefore be envisaged as a suite of integrated applications systems divided into three basic components on the basis of their intended functionality [5]:

(1) The *Clinical Support Systems (CSS)* being used in a front-line capacity, comprising the following sub-systems: Hospital Information System (HIS), Clinical Information System (CIS), Laboratory Information System (LIS), Radiology Information System (RIS), Picture Archiving & Communication System (PACS), Pharmacy Information System (PhIS), Critical Care System (CSS), Decision Support System (DSS)

(2) The *Healthcare Information Management and Support Services (HIMSS)* for the integrated large-scale data repository, would include Lifetime Health Records (LHR) Repository, Lifetime Health Plans (LHP) Repository, Health Records Management System (HRMS), Healthcare Information Management System (HIMS)

(3) The *PLHP system* Used in an integrated manner, these WAN-interconnected applications would allow for the collection and generation of the data necessary for PLHP formulation;

and in addition provide data and services intended to enhance national healthcare policy-making and to support medical research. Figure 2 [5] gives an overview of the LHP project.

The net effect of the LHP and its constituent components (PLHP, HIMSS and CSS) is intended to enhance overall healthcare quality and also the individual productivity of practitioners and institutions. Over the long-term, the proactive and preventive nature of LHP utilisationin which wellness preservation is accorded equal importance to illness treatmentis also expected to control and perhaps even reduce expenses associated with healthcare and support services. The following sections will discuss the functionality and workflow of the three subsystems.

Clinical Support Systems

The major objective of the CSS is to improve the workflow of healthcare practitioners, both clinically and administratively. In essence, CSS applications will provide support for clinical and administrative services at healthcare facilitiesincluding consultation services, investigative requests (pathological and imaging), results retrieval, diagnosis, treatment, drugs prescriptions, etcwhile concurrently creating the Electronic Medical Records (EMR) which contribute towards the continuous updating of the LHR database system. All CSS functions will contribute directly towards on-the-ground support of medical practitioners during encounters with patients; thereby allowing high-accuracy diagnosis, more effective treatment and enhanced level of professional care

Delivery of such services assumes transparent cross-institutional access of past medical recordsdocumenting treatments, drug prescriptions and earlier health plans. CSS would also provide decision support in terms of diagnosis and treatment; particularly for pharmaceutical dispensation and clinical test administration. In addition, scheduling, monitoring and consolidation of all relevant patient datain both a wellness as well as an illness contextwould also be handled by CSS, so as to present the clinician with a comprehensive and logically-ordered outlook. To achieve this objective, it will be important for CSS to synergise with the all Teleconsultation applications capable of generating a variety of data formats, thereby enabling their collation and integration into the EMR database.

CSS applications would be sited at servers maintained by the major regional medical centres, but made accessiblevia WAN connectionfrom primary service dispensation sites and clinics. In this manner, primary dispensation of healthcare will benefit from CSS services, while simultaneously generating the required EMRs that will in turn contribute towards the LHRs and hence PLHPs.

Healthcare Information Management and Support Services

The HIMSS is a set of applications geared towards maintaining repositories for LHRs and LHPs. The former are basically a systematic aggregation of various episodic EMRsboth illness and wellness relatedpertaining to an individual, collated from various health institutions across the nation and hence constituting a comprehensive womb-to-tomb medical history. One HIMSS objective would be to provide LHRs to CSS users, thereby enhancing diagnostic and treatments procedures. LHPs on the other hand are summarised and personalised health-plans for individuals, which integrate all episodic and situational subplans ie immunisation and rehabilitation programs. HIMSS would be concerned with LHP storage and retrieval. Personalisation of LHPs would be undertaken by the PLHP component of the LHP project to be discussed later. HIMSS would be located on central server, but would be linked and constantly accessed by various CSS sites in order to ensure LHR-to-EMR consistency. The HIMSS workflow [5] can be categorised into four major activities:-

LHR Collection

The LHR can be envisaged as a virtual entity realised via the establishment of relational links between the central LHR repository and the remote EMR storage sites across the nation. LHR collection then would then constitute the maintenance of data links and EMR collation activities.

PLHP Formulation

PLHPs are formulated based on comprehensive information in the LHRs, which will be discussed later in a later section. It is important to note that the HIMSS would have to initiate this process by sending the LHR to the PLHP component for the initial formulation, and subsequently sending the PLHP for updates whenever necessary.

LHR/LHP Management

HIMSS would be responsible for the data integrity of both LHRs and PLHPs. This is an extremely important activity as the two repositories are central to the LHP project, therefore proper and efficient database management is imperative.

Group Data Services

The effective delivery of healthcare services hinges on the ability to deliver proactive value-added services to different client segments on a timely basis. While the other projects such as Info/Edu and Teleconsultation services address the healthcare needs of certain individuals, the impact is constrained by the healthcare industrys difficulty in identifying and delivering the appropriate service to suitable clients. Irrespective of the access enablers, distribution channels and technology employed; these services need to be packaged according to usage patterns, demographics and behavioural psychographics. HIMSS would facilitate such studies as a suite of services known as the Group Data Services, provided by a component known as the Health Information Management System (HIMS).

HIMS would exploit the data within the EMR, LHR and PLHP repositories to evaluate the effectiveness of programs and products. This will enable the focussed delivery of medical services so as to be more proactive and effective *vis-à-vis* the end-users. Examples of such services include:- (1) data mining for forecasting and resource optimisation, (2) statistical and trend analysis, (3) market research, (4) publication of regulatory documents, (5) reports to R&D institutions (ie drug effectiveness studies), (6) financial data analysis, (7) analysis for community action planning, (8) analysis for policy formulation, (9) analysis for epidemiological and large-scale health surveillance, and (10) quality assurance and service evaluation.

Group Data Services would enable regulatory organisations to obtain strategic information so as to better control and guide

healthcare activities. It is anticipated that healthcare planners and administratorsie in the Ministry of Health (MOH), pharmaceutical companies, community health organisations, private service providers and R&D organisationswould benefit from such information services. Specific services made possible include:- (1) epidemic control, (2) pre-emptive alerts (for potential outbreaks of diseases), (3) drug monitoring and control, and (4) real-time market analysis of products and services.

Personalised Lifetime Health Plan System

The third component of the LHP project is the PLHP system, which can also be considered to be its ultimate objective. The major role of this component would be to generate individual PLHPs tailored to specific wellness and illness requirements. Once generated, the resulting PLHPs would be stored in the HIMSS LHP repository.

An individual would typically encounter many situational healthcare plans in his lifetime, these include immunisations, various disease prevention plans, treatment and rehabilitation programmes and geriatric care packages. The PLHP would integrate all existing medical records generated through encounters with healthcare system (the past), with all recommended plans assigned by various service providers (the future). This intelligent amalgamation of EMRs and LHRs is intended to be easily understood by individuals so that they are able to know their state of wellness and illness. This places them in a much better position to make well-informed health-related choices. The PLHP system would also chart and monitor an individuals state of wellness and illness in relation to known medical and family records.

The value-added component of the PLHP system would be extrapolated information and advice automatically formulated from the recorded data. In addition, the PLHP is intended to dynamically adjust itself with respect to changes in an individuals state of health, ie during temporary disablement or during occurrence of a chronic illness.

PLHPs may be generated on demand by individuals or via medical service providers, in particular general practitioners via their Teleconsultation workstations. They may then be used as a basis to provide continuous and consistent healthcare. It is anticipated that extensive PLHP functionality will be provided by the following modules:-

Generic Planner

At present, there exist situational health planssuch as immunisation, cervical screening, breast examination, health screening, ante and post-natalthat are delivered to the general public through various means. This module would integrate existing health plans together with pertinent HIMSS information to formulate value-added integrated generic plans.

Personalised Planner

This module would tailor the relevant generic plans to the specific needs of an individual based on LHR information. This would yield a PLHP comprising both wellness and illness plans. The wellness plans are intended to educate individuals so that they understand the exact state of health, and are subsequently able to take measures required for preservation or improvement. On the other hand, the illness plans would enable individualsor their familiesto manage their weakened conditions so as to ensure a speedy recovery. This would also cover the required post-illness actions ie consultation appointments, rehabilitation programs, personalised illness information and context-sensitive education material.

Triggering and Monitoring Module

The PLHP would incorporate various alert mechanisms which would prompt individuals to refer to their PLHPs for additional details. The Triggering and Monitoring module would also monitor the effectiveness of healthcare plans while in execution. A few services envisaged within the scope of this module are:-

Reminder Service: Within the context of wellness, this service would distribute reminders for immunisations, recommended medical screening, etc. During episodes of illness, reminders would be for follow-up visits, medical check-ups, specific screenings, etc.

Information Routing to Providers: This would be useful in scenarios requiring home-care monitoring, continuing treatment procedures, etc. The Information Router module would facilitate the delivery of critical information to relevant healthcare providers.

Donor-Recipient Matching: There are numerous obstacles in the present healthcare system for donor location with respect rare blood types and organ transplants. This module would provide a call-up facility to alert prospective donors and coordinating agencies, thereby providing a systematic large-scale mechanism.

Alerting of Selected Groups: This could be used to deliver important announcements in response to potential epidemics, health-alert warnings or forecasted diseases outbreaks in localised areas. The announcement may be narrow-casted ie disseminated to individuals with specific PLHP profiles, thereby enabling them to act accordingly.

Figure 3 [5] gives an overall view of the entire LHP project and shows the inter-related functionality of the various modules.

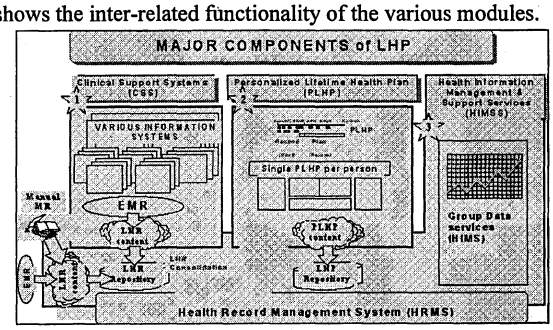

Figure 3 - Integrated view of LHP

Conclusion

The Malaysian telehealth vision specifies the development of innovative systems, services, infrastructures, skills and shared values. The Multimedia Development Corporation (MDC) [1], a government appointed regulatory authority, is spearheading

the task of assembling a critical mass of local and international corporations specialising in advanced technologies to work towards the implementation of the seven flagship applications. At this stage, the Concept Request For Proposals (CRFP) for telemedicine applications have been released and by Nov 1997 proposals are expected from participating organisations. As of Jan 1998 development and implementation will commence on the four major components, with the completion being targeted for 2003.

It is anticipated that current levels of expertise, planning, research and administrative responsibilities should be enhanced and geared toward telehealth realisation ie a cutting-edge healthcare system characterised by individual-centred and wellness-focused services. For maximum effectiveness, telehealth should feature informed and empowered individuals who are well informed on healthcare issues and able to select lifestyle and health management options resulting in sustained wellness. These services will be provided at home or close to the home. They will be seamless in implementation, and continuous in presence and tailored to the individuals and communitys requirements.

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