

**E-Health in Digital City
- Patient-Oriented Integrated Services**

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Abstract

A Digital City must have ability to offer (e-)health care population-wide. Telemedicine has been developed as one option in many developed countries using advanced information and telecommunication technologies in healthcare sector. Home-based and integrated health services will offer patients a better chance to gain quality of life and reduce the stress and time. Improved quality of life through a managed care program will be especially valuable for meeting individual patients needs regardless of the location, but the network connection. Offering integrated services from one or more service providers in a systematic approach becomes a challenge for such medical care. In addition to building up information and network infrastructure, prevention and traditional Chinese medicine might be addressed on in the development of e-health and telemedicine in China.

Keywords

Service development and management, Telemedicine, Application integration, Public health care.

1. Introduction

The concept “Digital City” is about the digitalization of all kinds information from the real world. People in the city could receive the digitized service in digital format. E-health is defined as the use in the health sector of the digital data- transmitted, stored and retrieved electronically – for clinical, educational and administrative purposes, both at the local site and at a distance. With an attempt to improve medical care population-wide, this paper introduces the development of e-health, or telemedicine narrowly speaking, from the technical and research perspectives. Telemedicine uses technology to deliver medical services to patients at the point of needs. Based on the introduction, some suggestions are made for developing telemedicine in China.

2. Telemedicine in E-health

Telemedicine

Currently and widely accepted definition of telemedicine is taken from EU Commission's program ”Advanced Informatics in Medicine”.

Rapid access to shared and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or relevant information is located (COM, 1997).

This definition can be understood from two perspectives. One is the patient’s point of view, which is about the healthcare services what patients can get. The other one is the medical institution’s point of view, which is about the communication between patients and healthcare parties. However, such a communication takes place around a patient. The need for telemedical services is based on the need to communicate between parties in the health care. When a patient moves, his information as a patient should and could move, too. The greatest impact of telemedicine should be on the patient, their family and their community. By using telemedicine technologies, it reduces travel time and related stresses to the patient.

Telemedicine is defined as consisting of the following components (USA, 1997):

- the delivery of health services (including clinical, educational and administrative services);
 - at a distance;
 - through the transfer of information, including audio, video and graphical data;
 - using telecommunications; and
- involving a range of health professionals, patients and other recipients.

Telemedicine can be divided into three areas: aids to decision-making, remote sensing, and collaborative arrangements for the real-time management of patients at a distance (Scannell et al., 1996). As an aid to decision-making, telemedicine includes areas such as remote expert systems that contribute to patient diagnosis or the use of online databases in the actual practice of medicine. This aspect of telemedicine is the oldest in concept. Remote sensing consists of the transmittal of patient information, such as electrocardiographic signals, x-rays, or patient records, from a remote site to a collaborator in a distant site. It can include transmittal of grand rounds for medical education purposes or teleconferences for continuing education. Collaborative

arrangements consist of using technology to actually allow one practitioner to observe and discuss symptoms with another practitioner whose patients are far away. Two-way workstations which provide smooth digital motion pictures have been integral to the long distance, real-time treatment of patients.

Services Moving

The concept of telemedicine can be traced back to the late of 60s (Scannell et al., 1996). Each of the three areas above is limited to aspects of medical diagnosis, patient care, and education. It includes human as well as veterinary medicine, and includes the technical aspects as well as the clinical concerns. Areas of patient record storage or shared hospital and computer resources are not addressed since they do not relate directly to patient care. Thus, in the earlier stage of telemedicine, patient care has been focused on, but not patient's information and services that patients would get.

Important features in healthcare can be described in terms of patient, doctor and patient care. Additionally, relationships between the patient and doctor and services that patients get have been improved due to advanced technology development. Here, patient is the concept as a group including patient's family members at small and a support system from the community at large. The doctor contrasted to the patient is another group that consists of all health care professionals involved in giving patient care. The parties are potential communicators in telemedicine applications, i.e. patients, health care parties¹.

Table 1 is formulated to observe the changes in the health care as time being. In the old time, doctors go to patient's home to offer services. Later, patients go to visit doctors to get services. At present, patients' information in electronic/digital format moves in-between clinics and doctors. Patients could stay where they want for cares. In the future, it will be the services that move from clinics through doctors to patients. However, the modes for service provision will coexist to meet different needs in certain circumstances.

Historically, understanding a patient's illness is arrived at through lengthy interviews, resulting in a very individualized understanding of the disease. With the advent of medical instruments such as the stethoscope, the thermometer, more and more sophisticated electronic methods of recording and quantifying health conditions (ECG's², X-rays, etc.), objective means of diagnosis has less to do with the subjective experiences and more to do with the extent, to which a patient typified a particular pattern of disease. We see this as a shift from a reliance on communication to a

¹ According to the classification of From et al. (1999), the health care parties consist of:

- General practitioner (GP)
- Pharmacy
- Medical library
- Hospital
- Surgical department of a hospital
- Dermatological department of a hospital
- Pathological department of a hospital
- Radiological department of a hospital
- Clinical chemistry laboratory.

² ECG stands for Electrocardiograph.

reliance on information in the ordinary practice of medicine. This movement becomes more complicated with the advent of telemedicine.

Moving services, which are usually obtained in a clinic, to patient's home requires technological help, e.g. communication channels between the patient and the clinic to transfer essential data of patient's conditions in terms of risk factor. Some new related instruments like ECG are already developed for such usage and some like sphygmomanometer are coming soon. However, there is a lack of research on how technology could be applied in the service packages. The future service will be a collective package dedicated to individual patients' needs. By "moving service", patients will be provided with all necessary cares, but only through one terminal and one service provider. This would be realized with help from computer-based systems and advanced telecommunication technology. They provide more options not only to patients, but also to healthcare professionals in considering quality of service and cost-effectiveness.

Table 1. Service Moving as Future Health Care

	Doctor Moving	Patient Moving	Info. Moving	Service Moving
Telemedicine participation			Remote diagnosis, Remote sensing, Distant patient management	Telemonitoring, Telecardiology, Teleconsultation, EPR service, Remote diagnosis. Telemonitoring Internet-based application systems, etc.
Technology applied	Simple medical instrument	Simple medical instrument, Complicated medical instrument	Simple & complicated medical instruments, Remote sensing, Telecommunication & information technology, Advanced medical treatment with computer supported systems	Telecommunication, Telemonitoring devices, Network, Simple & complicated medical treatment, Remote sensing, Advanced medical treatment with computer supported systems
Patient care & Service provision	Doctors visit patients at home, Face-to-face care	Patients go to visit doctors in the clinic Face-to-face care	Patients go to visit doctors in the clinic Remote diagnosis Face-to-face care	Patient stay at home, or Patients go to visit doctors in the clinic, and Face-to-face care
Communication between the patient, doctor and clinic	Face-to-face	Face-to-face, Phone	Face-to-face, e-mail, phone, videoconference, etc.	Face-to-face, Internet, mobile/ISDN phone, e-mail, videoconference,

Notes: *Info.* – Information

EPR – Electronic Patient Records.

ISDN – Integrated Services Digital Networks.

Definition of Problem

Neglected prevention and inappropriate long-term treatment of patients after acute coronary events, necessitate a fundamental reform to improve patients' outcomes and quality of life, as well as the cost-effectiveness of treatment. Future preventive measures need to focus on establishing risk factor profiles in individual patients, accurately identifying those at risk, and actively intervening to maximize the ability to change that risk.

There is a lack of structured and systematic information on different treatments and decisions, which physicians are supposed to give to their patients to help them make informed decisions about their healthcare (Pater, 2001). We rather see this as a common problem for all healthcare parties, that is effective communication channels in a systematic approach. Solving this problem will help increase the effectiveness and cut the cost of such services, and therefore make them more readily available to those in need.

Home-based healthcare will lift focus from isolated drug treatment and invasive cardiology to multidimensional rehabilitation with focus on quality of life at home or the place where the patient prefers. Such a service is expected to ensure that patients will get not only their lives extended but also an increased quality of life. As defined in the Currell et al. (1998), the services via telemedicine should be:

- That there is no difference in the outcomes of care delivered remotely via telemedicine compared with face to face care.
- That there are no differences in the economic consequences of care delivered remotely via telemedicine compared with face to face care.
- That there is no difference for patients/clients in the acceptability of care delivered remotely via telemedicine compared with face to face care.
- That there is no difference in professional practice during the delivery of care delivered remotely via telemedicine compared with face to face care.
- That there is no difference in the transfer of skills between clinicians, in care delivered remotely via the medium of telemedicine, compared with face to face care.

From the medical institution's point of view, it is important to have an evidence-based systematic approach to ensure the quality of services and make the diagnosis more independent from the experience. By now, no such service applications have been built up around this kind thinking yet.

Research Focus

Based on the discussion above, some research concerns are identified and described below:

- *Secured communication* – (Tele)Medicine requires a high level of confidentiality when it comes to information concerning patients. It is therefore quite a good candidate for applying new technical solutions and policies related to security and privacy. Thus, secured distributions of medical information in the service provision will have to be addressed as a priority.
- *Application integration* – Technologies to be applied have individually considerable potential to support the delivery of the rehabilitation service and some

have been exploited in systems providing each a specific service. But their impact will be even much greater when the potential synergy between them is exploited by providing the different services in an integrated manner. Thus, new methods of integrating different applications and tools will be explored.

- *Management of service provision* – Monitoring a medical examination remotely brings a new culture to the care and treatment process. How to manage services remotely could be tried with new technology ASP (Application Service Provider) in recent years. It connects service providers and service receivers in a controlled form by agreed telecommunication protocols.
- *Enhanced communications among involved parties* - The requirements of rehabilitation services are based on the needs for communications between parties involved. With open communication technology, e.g., Internet, patients could easily contact their doctors by e-mail, telephone, mobile phone, videoconference and other communication means will be easily adopted. How to make cooperation more effective is the concern.
- *Improvement of Process* - This effort shall be explored from radical changes that advanced technology applications. Some studies by Asa (2001) and Whitten and Allen () have already reported a number of changes in organizational structure, work process, staffing and information reporting and management systems. How to improve the process to achieve . Reactions to treatment via telemedicine from patients in rural areas are very positive because they could get expert help without leaving home (Robb, 1997).

Objective of Research

The overall objective of using advanced technologies in health care sector is to develop a spectrum of services for the patients and professionals. Advantage for doing this is obvious for those in rural areas and for those who should take a long recovery process at home after certain kind of surgery. Thus, the patients can be kept “on track” in the treatment and recovery progress, i.e. to be informed, observed, and even cared for until the patients are back to a normal life.

Some subgoals following this objective are:

- Supporting patients and patients’ family members as one user group by providing prevention and easy communications with healthcare professionals. Empowering patients in the treatment process by offering a variety of services to patient’s home.
- Supporting healthcare professionals by providing multiple communication channels between patients and professionals, between professionals and between professionals and administrators. Evidence-based medicine practice will be emphasized on.
- Supporting service providers to get external services from other service providers when needed, i.e. all services at one place.
- Encouraging and improving secured communications in telemedicine for public healthcare via Internet.

3. Rationale

The cardiovascular rehabilitation services would be developed on the basis of patient’s needs with easy technical assistance and better quality of service. If only

considering cost-effectiveness, teleconsultation saves about 1/3 cost compared to face-to-face doctor consultation (Mørland and Myhre, 1998), whereas telecardiology has caused the extra cost for patient (Halvorsen and Kristiansen, 1996). One study Bergmo (1997) concluded that patients would chose teleconsultation instead of visiting doctors due to the saved time and convenience.

Patient Orientation

Patient is a new concept for study. A patient is defined as “an individual awaiting or under medical care and treatment” (Merriam-Webster, 1997). “Care” and “treatment” are medical actions that make *patient* a narrow concept against the whole population. Patient is the focus in the rehabilitation services. In Norway, the legislation on individual patients’ rights³ aims to create a system with a focus on the patient. Patients initiate all services. All transactions around the services like treatment, nursing, and billing will come along as soon as a patient has visited a clinic or requested certain services. Patients are service receivers for whom the services should be developed. Today and tomorrow, healthcare services are facing more informed and educated patients than ever. It’s believed that healthcare will become less doctor-centered, and more community- and family-centered. Medicine itself will become more fact-based knowledge for everyone (Flower, 2000). The greatest impact of telemedicine is on the patient, their family and their community (Argy and Caputo, 1999).

Integrated Services

According to the clinical experience on using patient record (Curry and Sawyer, 1999), the system should be integrated rather than interfaced and stitched together because it will be important to bring together data from broad areas of operation. Provision of integrated services is a challenge in the future healthcare. By integration, it has to address the following issues:

- *Knowledge integration*, cardiac prevention and rehabilitation should be evidence-based medical practice. Here, evidence can be understood as knowledge. In other words, the cardiac prevention and rehabilitation should be knowledge-intensive service.
- *Application and service integration*, Implementation of integrated services for cardiac patients with other health problems. Two applications may have different healthcare and technical requirements. A party that needs to use both applications will have to implement the synergy of the requirements for each application. A standardized, yet flexible way of doing this integration is then required.
- *Skill integration*. Skills demanded may have to be expanded to achieve a common understanding of the problem. Remote diagnosis and expert diagnosis will help healthcare workers learn skills from other experienced practitioners.
- *Device integration*, A combination of traditional medical devices and net-based monitoring devices for distant patients. Due to the great mobility of patients, wireless network is added into the wide spectrum of services provided in healthcare.
- *Network integration*. With invoking services from other service providers, allowing to retrieve and transfer information across boundaries between local and regional,

³ The Patient Right Act came into force in 2000 and The Hospital Act in 2001. Some relevant reforms are taking place in 2001.

even international networks. Information sharing is generally accepted as the key to substantial improvements in quality of service.

- *Patient information integration from different systems.* The comprehensive information about a patient has to be integrated into a virtual on-line view through a unified interface and visualization environment.

- *Transaction integration.* One-step service would be expected in the integrated services. This could imply that all transactions around one visit or one treatment, e.g. insurance and billing transactions would be performed automatically.

Prevention as Priority

The cardiovascular disease will be taken as an example to explain why prevention is so important since it is among the biggest killers. Cardiovascular rehabilitation is moving to cardiovascular prevention and rehabilitation (Saner, 2000). Stokes (2000) points to the same tendency based on the practice of cardiovascular rehabilitation in the United Kingdom. Patient flows with cardiac diseases are generally divided into primary prevention and secondary prevention as people's age increases (Pater, 2001). Therefore, Pater suggests that the CHD prevention should start even from the children.

In some countries like USA, Canada, Australia and the United Kingdom, more official guidelines for cardiac rehabilitation and secondary prevention have been conducted (Williams M. et al. 1999; Stone J. et al. 1999; Goble A. and Worcester M. 1999; NSF for CHD⁴, 2000). In Norway, a number of research projects undertaken in the hospitals and clinics are aimed at analyzing the current status of the main determinants of population-wide coronary heart disease prevention (Pater et al., 2000). Pater's conceptual framework for public health practice in cardiovascular disease prevention is also aimed at controlling risk factors and risk behaviors on a population basis (Pater, 2001). These research topics follow up the international tendency.

However, significant challenges remain in terms of integrating and delivering appropriate individualized cardiac prevention, care and rehabilitation. Prevention must be taken into account in the health care services because it interrelates to care and rehabilitation. Prevention knowledge could be enriched from care and rehabilitation practice. Moreover, care and rehabilitation would give lessons for prevention.

4. Technologies and Services

Advanced prevention and rehabilitation services using various kinds of facilities including telemedicine devices will be explored as well as advanced services compared to the basic services around Electronic Patient Record (EPR), which allow all parties to view patients' information confidentially and differently. This research will cover both services, but focus on the advanced aspects. Discussing services together with technologies reveals that some services need and should be

⁴ CHD – Coronary Heart Disease. The government of the UK has made a strategic service framework for CHD rehabilitation.

implemented from technical help in a systematic environment. Only on unbroken care environments would services be well defined and provided.

Telecommunication and Information Technologies

Telemedicine involves the use of modern two-way interactive audio/video telecommunications, computers, and telemetry, to deliver health services to remote patients and to facilitate information exchange between primary care physicians and specialists at some distance from each other (Mitchell, 1998).

Treatment-oriented health service is the future development of telemedicine. Telemonitoring technology e.g. telecardiology⁵ might offer the possibilities to make cardiac rehabilitation programs available regardless of location and in a convenient manner for patients, by delivering faster, fairer and more appropriate services. Thus the patients will benefit from carefully planned and targeted services to address identified needs either in prevention or in rehabilitation. Different prevention and rehabilitation services must be tailored to each patient's needs, which depend upon the patient's specific health problems.

Table 2 Major Telecommunication and Information Technologies

Technology	Usage in POISE	Relevant Services
Electronic Patient Record (EPR)	Basic service: EPR-based catalog service	Patient registration. Authorized access to patient information. EPR-based Catalog services
Medical Net Instrument (MNI)	Monitoring patient's health conditions.	Interface with EPR. Risk assessment based on ECG algorithm specially formulated for patient's risk profiles. Telemonitoring.
Telecommunication	Communication protocols, e.g. Plain old Telephone services (POTS), Integrated services digital network ISDN, Internet Protocol (IP) and WAP protocol for wireless network and wireless medical instruments. Radio/video.	Evidence-based teleconsultation to patients. Evidence-based medicine practice for healthcare professionals. Evidence-based nursing. Communication means among all involved parties: email, multimedia e-mail, store and forward image transmission, video conferencing etc.
ASP platform	Service distribution of ASP via ASP platform	All kinds of services

Possible technologies for developing services over the Internet are listed in Table 2. In addition to well-known telecommunication and IT, Medical Net Instruments (MNI) and Application Service Provider (ASP) will be introduced. MNI is a kind of net enabled diagnostic device. The device has in its integrity with other systems, e.g. signal processing and transmission to the central system, and the interface with patient record systems, and 24 hours monitoring of essential signs for heart conditions. It brings integrated solutions not only for the diagnosis itself but also for relevant

⁵ Teleconsultation and telecardiology are major aspects in the development of telemedicine nationally and internationally. See Mørland and Myhre (1998) for more details.

services based on the diagnosis. MNI can be simply used via ISDN and mobile connections to the Internet. An ASP is a third-party entity that manages and distributes software-based services and solutions to customers across a wide area network (WAN) from a central data center. That is to say health care services could be provided as an e-business solution.

Integrated Services to Patients at the Point of Need

Services shall be provided at the point of needs. For patients, they should be offered better care at an increased level, e.g. the improved treatment, up-to-date information about their heart conditions, feedback to their monitoring signals, secured access to their own confidential records, easy communications with their own doctors and specialists on demand, and other healthcare professionals including nurses and home carers. Improving the patient's access to clinically relevant information can help improve the quality of care. In addition, usability will be considered also. Potential services could be thought of for patients and their family members:

- Basic services around EPR
- Evidence-based teleconsultation
- Telemonitoring device service
- (Expert) Diagnoses service
- Physical exercise supervision
- Progress control service

Integrated Services to Healthcare Professionals

Evidence-based prevention and rehabilitation, evidence-based nursing would be addressed in providing services to professionals close to the practice of Evidence-Based Medicine (EBM) (EBM working group, 2000). Beyond evidence-based medical practice, healthcare professionals will have to rely on secured data to offer their services to the patients in the rehabilitation program. They have to follow up the patients' progress and control the treatment plan. In addition, they will be informed about their daily tasks and responsibility for the patients they are in charge of. They should organize and use all services to patients in a systematic approach.

5. Few Suggestions

Many countries such as USA, UK, Norway and Sweden, Canada as well Greece, have already started building up these infrastructures nation-wide. In Norway, the government has made two laws⁶ for patient's right and hospital. Moreover, two IT-action plans⁷ have implemented to encourage technology application in health sector. Developing advanced healthcare system and telemedicine in China lacks support from information and network infrastructure at moment.

⁶ The Patients Right Act will be implemented in 2000, while The Hospital Act will be modernized and replaced in 2001. A primary care reform introducing a family doctor will come into force in 2001.

⁷ One plan is "More health for every bIT, 1997–2000" (<http://www.oecd.org/dsti/sti/it/prod/it-out2000profiles/norway.htm>). The other one is si@!, (say@! in English translation) 2001-2003 – Electronic **samhandling** in health and social sectors (<http://odin.dep.no/shd/norsk/publ/handlingsplaner/030011-120002/index-dok000-b-n-a.html>).

China has carried out open policy from 1979. Since then, China's economic growth has been phenomenal. At the same time national budget for health sector has been dramatically reduced. According to (Wong and Gabriel, 1988), current health care systems like Gongfei yi liao, Laobao yi liao⁸, and rural cooperative medical system (RCMS)⁹ have applied into different groups, workers in the enterprises and farmers in the countryside. Private insurance is coming as a new concept. Thus, the shortage of money in health care turns as a big problem not only in the countryside including rural areas, but also in the cities including state-owned enterprises.

To resolve these problems, integrated solutions from different sectors are expected. Advances of technologies would offer some better solutions. Telemedicine is a general term that refers to a wide range of technologies and applications. The concept is almost as broad as that of medical care itself. Thus, the initiative for its development should start with fundamental issues like government policy and long-term plan, patient management system, information and network infrastructure. Privacy and security of confidential patient information have to be ensured by laws and policies. Technology cannot solve all problems although telemedicine is very technology dependent. A few suggestions are proposed on the basis of development of telemedicine in other countries and the existing situations in China.

- Organize Co-efforts from different sectors. IT based service in health care is not only one single event, but the effort from many sectors e.g., education, health care, science and technology, social affairs and industry as well. Making broader use of computer in everyday life will result in the effect described in a Chinese proverb "One stone with two birds". Here, the expected result would be "one computer with more applications". A computer will be a tool to gain knowledge and services. The services will be provided at an individual level. E-learning, e-Health and e-Business could be concerned and planned at the same time. At a national level, one or more examples or model would be necessarily conducted to obtain experience in developing digital cities for further development. People in rural area and countryside should be tried as a new digital city for the future. There exists already a higher starting point to stand on compared to current such examples worldwide, e.g. from USA, Russia, Finland, Sweden and Norway.
- Apply new technologies into Chinese medicine. It needs a reform for the future and wider usage in the world. Chinese medicine is the biggest advantage we have in China in parallel with Western medicine. Introducing advanced technologies could improve Chinese medicine in an easy way for people to accept it. There will be a big volume of people who will benefit from using it, especially for people who have sources to make good use of Chinese medicine. Chinese medicine is facing not only China, but also the whole world. A distribution channel should be coupled with outsides where network has been used as a channel to offer public services. At present, there is no proper channel to retrieve information about Chinese medicine. Telemonitoring instruments for measuring the pulse in principles of Chinese medicine could be developed available via Internet.

⁸ Gongfei Yi liao and LaoBao Yiliao are two different health care systems carried out in state-own and private enterprises. All workers in the systems are covered and guaranteed by health insurance.

⁹ This system was first conceived during the 1950's through initiatives of communes and brigades in rural areas and is funded by yearly contributions paid by participants and subsidies from collective welfare funds.

- Take prevention a priority through multiple communication channels. A national digital library is in urgent to offer standardized teleconsultation for patients and health care professionals. Chinese people in general have a tradition and mind to take good care themselves by eating and doing exercises. Sometime, people make their own judgement and then take drugs at the first hand when they get ill.
- Combine Chinese medicine and Western medicine. Due to the influences of Chinese medicine for thousand years, people have better knowledge on treatment for frequently happened diseases e.g., the cold and some kinds of pain. Actually Chinese medicine has been accepted for treatment purpose in China and some Asian countries, but not in western countries, where Chinese medicine is run officially and legally only for removing and reducing pain. Chinese medicine has become more attractive in the last years because it is natural medicine and could be cost-effectiveness. The role for Chinese medicine in prevention should be expanded population-wide. Certain improvements or even a reform have to be thought of, for instance, more scientific measures for effects of treatment and more user-friendly traditional medicine production. The traditional medicine is often effective, whereas its smell and taste will stop many people taking it. Improvement in many aspects could be done to give the traditional medicine a new tele-life worldwide.

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