Integration Issues in Patient Mobility

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Sammendrag/Abstract:

One new tendency brought by telemedicine is the service moving compared to doctor moving, patient moving and information moving in the history of medical practice. By "moving service", patients will be provided with all necessary cares through one set of terminals or one service provider regardless where patients stay. Moving those services, which are usually obtained in a clinic/hospital, 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 e.g. in terms of risk factor for cardiac patients using web available instruments like ECG (electronic cardiograms).

The current technology, e.g. PDAs (personal digital assistants), wireless devices, means of telecommunication, embedded services, data warehouses etc., provides a solid base for building up a mobile patient infrastructure. The most important challenge is to integrate them together for the purpose of a mobile patient. Effective integration in a complex heterogeneous computing environment involves technical processes, standardization processes and people resources. Integrated services require a shift from a focus on systems within hospital environments to a patient oriented approach, a co-effort from general practice, hospitals, community services and patients.

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Integration Issues in Patient Mobility

1. Development of Telemedicine

Telemedicine has been 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 is the delivery of care to patients at any location by integrating communications technology and informatics with medical expertise. This is an emerging research and development field that could have revolutionary impact on the delivery of medical care. The goal is to improve access to high-quality medical care at affordable costs. Telemedicine is being driven by two converging trends: advances in enabling technologies (e.g., digital compression, multimedia) and telecommunications and increasing demand for access to high-quality medical care irrespective of location.

One new phenomenon brought by telemedicine is the service moving compared to doctor moving, patient moving and information moving in the history of medical practice. By "moving service", patients will be provided with all necessary cares, but only through one terminal and one service provider. This could be expected as integrated services or cares. Moving those 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 e.g. in terms of risk factor for cardiac patients using web available instruments like ECG[1]. The future services will be a collective package dedicated to individual patients' needs. Telemedicine would provide more options not only to patients, but also to healthcare professionals such as doctors and nurses.

Services Moving

One important feature in healthcare can be described in terms of patient, doctor and services and relationships among them (Zhang, 2001). In the old time, doctors go to patient's home to offer their services and medical care. Later, patients go to visit doctors to get medical services. At present, patients' information moves in-between patients, doctors and systems. Patients could stay where they want for obtaining a number of services, e.g. receiving medicinal instruction. In the future, it would be some kinds of services that move from the hospital to patients according to doctors' treatment plan. Patients will be able to get services they want via one simple terminal and one connection. However, these services will coexist and meet different patient's needs.

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, such technology has not been applied and included in the service development.

[1] ECG stands for Electrocardiograph.

Problems to be Resolved

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). This could be rather seen as a common problem for all healthcare parties. 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 cardiovascular prevention and rehabilitation 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. It is important to have an evidence-based systematic approach in cardiac prevention and rehabilitation. So far, no service applications have been built up around this kind of thinking.

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.

2. Patient Mobility

By patient mobility, it means (a) the ability of a patient to access (tele)medicine services at any UPT (Universal personal telecommunication) terminal on the basis of a patient's identifier from hospital's systems (or medical service providers) in universal personal telecommunications, and (b) the capability of the network to provide those services in compliance with the patient's service profile.

Patient Mobility - 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' rights[2] 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

[2] The Patient Right Act came into force in 2000 and The Hospital Act in 2001. Some relevant reforms take place in 2001.

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).

Patient Mobility - Integrated Services

To provide patient mobility requires an integrated system comprising a wide range of different services, which have to exchange a various kind of data, derived from broad areas of operations. Thus integration is taken as a big issue and a challenge for telemedicine where an advanced information technology and telecommunication technology are applied into medical practice. Telemedicine could become complicated as the medical institution itself. Therefore, effective integration in a complex heterogeneous computing environment involves both technical processes and people processes. Integrated services require a shift from a focus on systems within hospital environments to a patient oriented approach, a co-effort from general practice, hospitals, community services and patients.

Our survey is conducted by searching published papers from MEDLINE between 1996-2000. According to the survey, we divide integration issues into five categories from a social perspective, a technical perspective, a patient's perspective, a medical institutional perspective, and an economical perspective. Our research is based on technical perspective considering the others.

The current integration issues studied in telemedicine are listed in Table 1.

Table 1 Integration Issues in Telemedicine

Social perspective	• Doctors, patients and families as a community in health care • State initiative in USA (Lipson and Henderson, 1996) and region initiative in Norway (From et al., 1999). They include planning and coordination, development of networks, more limited program development, funding, building a telecommuni - cations infrastructure for telemedicine, and regulatory support and clarification. • Decision support for health care (Ambrosiadou et al., 2000) • Integrated healthcare delivery systems have been focused heavily on their level of various partnership integration (i.e. service differentiation strategy) in order to offer a full continuum of care (Lin and Wan, 2001).
Technical perspective	• Integration of information and imaging systems (Smith et al., 1999; Chimiak and Lopez, 2000; Lewis et al., 1999;) • Integration with electronic patient records (Kuzmak and Dayhoff, 2000; Hyde, 2001; Xu et al., 2000). • Computer Telephone Integration (Prasetio, 1999). • Smart Card (Ryabova et al., 1997). • Virtual reality as an interface (Satava and Jones, 1996).
Patient's perspective	• Home care - Remote video technology (Johnston, 2000) • Telerehabilitation (Liu and Miyazaki, 2000) • Patient satisfaction (O'Connell et al., 2001) • Integration of teleconsultation and face-to-face consultations • Real-time interactive teleconference clinical consultations (Gustke, 2000) • Medical counseling through computer communication networks (Yoo, 1998) • Telephone call (Ferrer-Roca et al., 1998) and Nurse visiting as a supplementary to Telemedicine (Allen, 1999**)** • Integration of health care (Jong and Jackson, 2001) health service as a whole package.
Medical institutional perspectives	*Medical practice* • Integration of primary and secondary care (Harrison et al., 1997) • teledentistry (Wheeler, 1999) • Distributed medical intellegence (Warner et al., 1996) *Medical education* • Medical education over the Internet (Taekman, 1996**)** • Computers and Digital evolution (Chan, 1997) *Medical service* • Telepsychiatry service (Urness, 1999)
Cost-Effectiveness and Quality of Service	• Because the vast proportion of telemedicine operating costs are fixed, increased utilization causes reduced cost per visit and results in a cost saving compared with providing these services via a non-telemedicine program (McCue et al., 2000). • Transportation saving (Maass et al., 2000) and time saving Bergmo (1996). • No analyzable data for the cost effectiveness (Currell et al., 2000).

Source: Zhang (2001).

Major problems to build up patient-oriented integrated services from the technical perspective include:

- No clear definition for integration.
- Different existing data formats and big number of legacy systems.
- Lack of the common standard for the data exchange.
- Information overload and a systematic approach not there yet.
- Lack of the research for medical intelligence systems.

By focusing integration issues in medical service development from the survey conducted by us (see Table 1), we purpose some important aspects to be concerned in the service development and give each issue a brief description below. This indicates that the use case diagram is drawn on the basis of the discussion here.

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 get necessary knowledge and improve skills from other experienced practitioners.

Device integration, a combination of traditional medical devices and net-based monitoring devices for distant patients. To support the mobility of patients, wireless network is added into the wide spectrum of services provided in healthcare, which should be focused on also.

Network integration –With invoking services from other service providers, allowing to retrieve and transfer information across boundaries between local and regional, even international networks. Information sharing is generally accepted as the key to substantial improvements in quality of service.

Patient information integration from different locations. 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.

3. Integrated Service Development – Project Proposal

Cardiovascular Rehabilitation as a Case

Cardiac patient and rehabilitation program can be taken as a good example for the design of patient mobility. A big number of patients have to receive the surgery and then will use a long period for recovery to get their life back to normal. It will cost very much if all patients take the care and treatment in the hospital because of the use of resources. Still patients should be continuously controlled and cared. How to provide a proper rehabilitation program based on individuals needs? How to control patients' progress in the recovery process? How to make things easier and secured for patients in particularly when they need help? How to apply new technologies to promote the appearance of patient mobility?

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 CHD[3], 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. Taking Feiringklinikken as an example, prevention must be taken into account because it interrelates to care and rehabilitation. Prevention knowledge will be enriched from care and rehabilitation practice.

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 implemented from technical help in a systematic environment. To provide a patient with stable and secure services requires a well-defined infrastructure.

Telecommunication and Information Technologies

In telemedicine, teleconsultation and telecardiology[4] might offer the possibilities to make 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. Cardiovascular prevention and rehabilitation services must be tailored to each patient's needs, which depend upon the patient's specific heart problem and other health problems.

The project has chosen to focus especially upon the technologies 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 a net enabled diagnostic device similar to a computer ECG recorder developed by MedIT. 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 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. Feiringklinikken is to be an active ASP and offer their rehabilitation services to patients with heart or other problems.

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

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

Table 2 Major Telecommunication and Information Technologies

Technology	Usage	Potential 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.	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.
Application Service Provider (ASP) platform	Service distribution of ASP via health care platform.	All kinds of services

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 care providers. 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 and 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 described, 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.

Different Services to Different Actors

The aim is to build up a prototype of service system to patient's home after surgery on the basis of individual patients' needs using IT, communication technology and health monitoring equipment like ECG as well. Risk factor analysis is important to be studied in the project, e.g. how to implement it in the system according to the signals obtained by the system from the ECG remotely. Cardio Control in

Holland and MedIT AS in Norway have produced digital devices in connection with patients' record systems, which could be managed by different hospitals.

It should be noticed that the patient is a major actor involved in the system. Other actors like the doctor and the nurse relate to the patient to meet different needs of patients. Figure 1 is a simplified use case diagram showing the main system functionality.

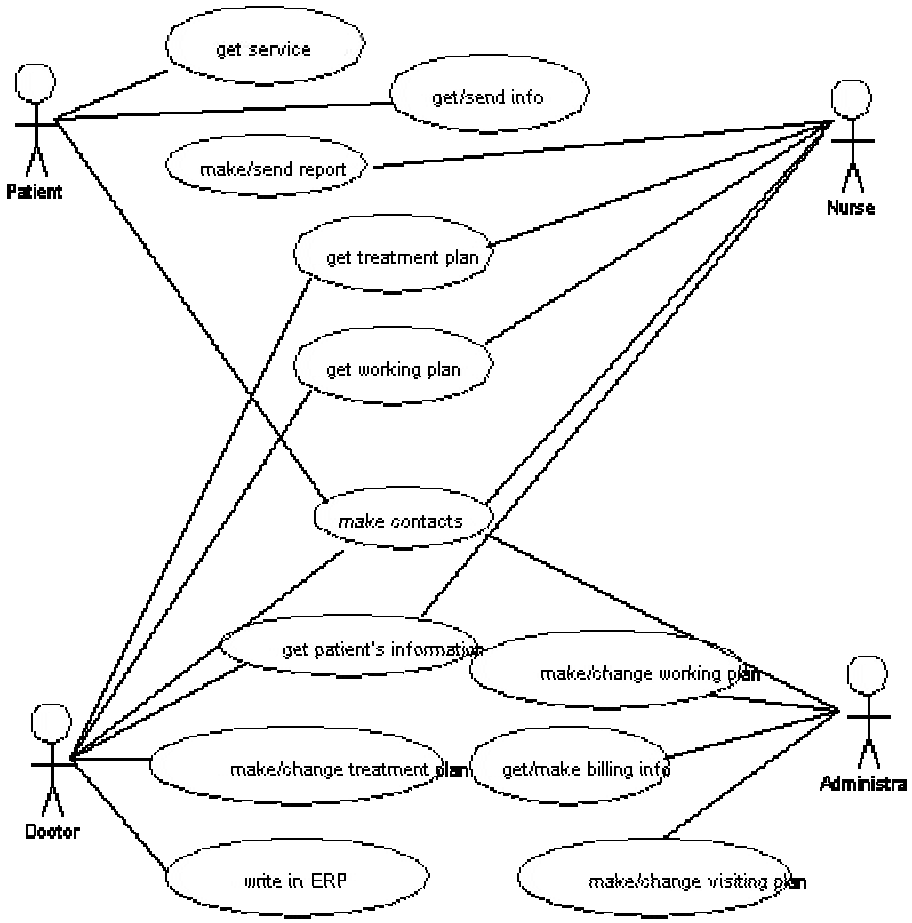

Figure 1 Simplified Use Cases of Cardiovascular Rehabilitation System

Use Case Name: get service
Description: A patient can get different kinds of medical services, such as getting an ECG record, looking his/her partial earlier records, contacting his/her arranged doctors or nurses, getting on-line consultation, getting supervision as well.
Actor: Patient

Use Case Name: get/send info
Description: A patient can get information about his/her health condition, assigned treatment or billing information.
Actor: Patient

Use Case Name: make/send report
Description: After visiting the patient, a nurse makes a report and sends it to be saved in the database where a doctor can later find it and read.

Actor: Nurse

Use Case Name: get treatment plan
Description: A nurse/doctor gets a treatment plan made by a doctor from a database.
Actor: Nurse, Doctor

Use Case Name: get working plan
Description: A doctor and a nurse can get their working plans made by an administrator and stored in the database.
Actor: Nurse, Doctor

Use Case Name: get patient's information
Description: A doctor or a nurse can get all related patient's information like monitoring information, nurse's reports, etc.
Actor: Nurse, Doctor

Use Case Name: make/change treatment plan
Description: A doctor makes or changes treatment plans and saves them in the database.
Actor: Doctor

Use Case Name: write in EPR
Description: A doctor saves all related information into patient's EPRs.
Actor: Doctor

Use Case Name: make contacts
Description: Contacts here mean necessary communications among those actors. A patient can contact a doctor or a nurse or an administrator. Such communications could occur in between other actors also. Communication means can be telephone, e-mail, SMS or voice SMS in the future.
Actor: Patient, Doctor, Nurse, and Administrator

Use Case Name: make/change working plan
Description: An administrator makes or changes working plans for doctors and nurses.
Actor: Administrator

Use Case Name: make/change visiting plan
Description: An administrator makes or changes visiting plans for patients' relatives.
Actor: Administrator

Use Case Name: get/make billing info
Description: Administrator gets or prepares relevant financial documents.
Actor: Administrator

Research Issues

Some research issues could be studied further around this case. They include:

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 risk analysis in contexts –The result from risk assessment directly relates to the diagnosis and treatment plan. For some distant patients, the degree of ECG surveillance is very critical since ECG is the only device to rely on in order to get essential prognostic parameters at the moment with telemonitoring device. It's encouraged to build a model for risk analysis and ECG algorithm in the context of home rehabilitation.

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 Recovery Process - This effort shall be explored from the patient's perspectives by following up patient progresses. Some issues might include: How to improve the recovery process by better prevention and rehabilitation services to patients? How easy the advanced technologies to be used at home? How effective the services aid patients recovering from surgery? Monitoring a medical examination remotely brings a new culture to the care and treatment process.

4. Conclusion

Patient mobility will appear as one future choice for patients to gain medical treatment and care as new technologies are created and applied. Co-effort must be made from difference communities where patients could be involved. Only when the service is available, could patient mobility have more impacts on patient's life.

The future service could be seen as a collective service package dedicated to individual patients' needs. This means that patients will be provided by some necessary cares through some kind of terminals such as PDA, PC with access to Internet. In addition to the benefits to the patients, healthcare professionals could be provided with more flexible and effective work in terms of quality of service and cost-effectiveness.

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