
Collaborative And Multimedia Medical Technologies In The Future Management Of Health Care

Introduction

Informatics and telematics are in developing fast, but how will these new areas influence the structure and delivery of health care in the future?

Despite promising results in medical informatics research, sustainable use of information in health care has not been achieved because of the diffuse nature of the technical innovations. In light of future challenges, such as growing numbers of the elderly, chronic diseases, more advanced medical technologies, insufficient health care budgets and decentralisation of health care systems, it has become essential to achieve a critical mass for meeting these challenges.

In the past, telemedicine was synonymous with video-conferencing in health care. When we discuss the future influence of telemedicine, the definition has to expand into practising medicine at a distance, meaning use of informatics and telematics in all medical specialities. Telemedicine will include everything from a situation where a physician examines or treats a far away patient to consultations between medical professionals at some distance apart.

WHO defines telemedicine as *"Experiencing health and social care using interactive communication of sound, images and data. This includes diagnosis, consultations and treatment as well as education and transferring of medical data"*.

Accordingly, the telematics applications that we deal with will give support to patients or citizens who are isolated or otherwise inaccessible for the purposes of professional care. Telematics can diminish geographical distances in sparsely populated, rural areas as well as when consulting with professionals on another continent. Professional competence is then available when and where needed, independent of time and geographical location.

We have therefore considered the necessity of a broader vision of the coming society, to include:

- Monitoring social and cultural change in a multidisciplinary, integrated way.
- A continuously updated analysis of diverse needs and effects in the field of health.
- Proposed technical and organisational solutions to meet the range of diverse needs
- To achieve equal quality of care for the patients, safety for patients and relatives
- To achieve sustainable work environments for care providers
- To achieve sustainable growth for society.

A changing infrastructure has opened up possibilities. Telemedicine has developed from utilising local solutions within the health care provider, to the global Internet. Telemedicine will also use wireless LAN and 3G systems.

We also see future challenges in the shape of citizens wanting greater access to expert knowledge, and an increasing population of older people, not only in Sweden but also in all

Western countries. Will informatics and telematics, and solutions built on these technologies, improve health care and make it more effective and more equitable?

Our belief is that future health care will be built on knowledge networks. Information on what specialist is needed will be sought at the appropriate health care level, by the responsible physician or nurse, within primary care, university hospital, or other sources, where the best expert knowledge can be found for the specific disease. Future telematic applications will also give support both to the patient directly and to the relatives. One must also be aware of the very fact that science and best practice are changing over time, new knowledge develops as the old disappears. We are in a process of life-long learning.

The concept of telemedicine must therefore fully include and support the Telematics and Informatics in the Health Care Process.

Areas For Telemedicine

Today, different areas that are using telemedicine applications are under rapid development:

- Imaging diagnostics (radiology, ultra sound, nuclear medicine, cardiology)
- Oncology (distributed radiation therapy)
- Laboratory medicine, incl. pathology, cytology, haematology and bacteriology
- ENT
- Orthopaedic
- Dermatology
- Psychiatry
- Geriatrics, including telematic support for Hospice care, Stroke rehabilitation and even decision support in demens examinations
- Eye evaluation
- Home care - both health and social care
- Acute care, fixed networks as well as mobile solutions also including ambulances
- Conferences, both medical and administrative (education)

Some examples of technical support for application of telematics:

- Medical devices, different sensors for physiological parameters, e.g. heart frequency, heart sound, blood gases
- Electronic patient record which includes referrals and answers between primary care – hospital, hospital – hospital, county care and community care (different levels of care). Transmission of multi-medial information
- Decision support system, DSS. Pilot project for treatment of hypertension. A qualitatively better treatment can be given with a potential for cost reduction

- VR technique with surgery in a distance using 3D technique fusing different picture modalities to visualize, e.g. a virtual mouth intended for educational purposes. With VR technique, there are projects intended for development of milieus that shall make it easier for relatives and care personnel to understand how stroke patients experience their surroundings.

Effects Of Telematic Solutions

Effects that we have documented so far in telemedicine applications are:

- Reduced travel costs
- Fewer referrals
- Empowerment of the patient
- Increased safety and quality
- Easier recruitment of medical personnel
- Better quality of service

Professional Networking Between Specialist Physicians

In order to change the delivery of health and social care to be more efficient and qualitatively better one should use telematic applications in the areas described below. In many areas one should utilise regional co-operation but the different areas can also be expanded nationally and globally.

Telepathology

Reasons for using telepathology can be summarised as follows:

- Improved treatment strategy
- Reduced time for diagnostic evaluation.
- Improved competence for diagnosis and treatment.
- Improved communication between physicians.

With the use of the internet and the development of IT infrastructure it may be possible in the near future, when a second opinion is needed, to refer the pathological image together with the verbal description of the case to a "super" specialist. At that moment it is unimportant if the specialist is situated in New York or Sydney. Information transfer is cheap, but knowledge is expensive.

Neurosurgical And Trauma Consultations

In case of emergency and multi-trauma patients in a general hospital an external specialist can be consulted immediately on-line for a decision on further treatment, or transfer to a regional or university centre. Trauma centres are only one per health care region, and therefore the number of specialists on stand-by duty could to be reduced by circulating them between the different centres.

Clinical Neurophysiology

Evaluation of clinical investigations, EEG and EMG, can be transferred electronically to centralised evaluation.

Psychiatry

Videoconferences are in routine use in psychiatry worldwide, where they increase availability and diminish the need for travel. The effect is more efficient utilisation of resources.

Eye Evaluation

Screening of diabetes patients can be centralised because this patient group needs close follow up of their fundus status. Acute distant diagnostic can also be performed using telematic solutions.

Image Diagnostics

Diagnostic radiology

Diagnostic radiology is so far the most used application for telemedicine, and the area has become more advanced using new technologies. Extensive digitalisation projects in radiology have taken place all over the world, a prerequisite for making a "big" virtual radiological department with extensive possibilities to transfer image information to make cost effective structural changes of the delivery of health care.

Ultrasound

Second opinion and specialist opinion can easily be achieved by using telematic solutions. This approach will give more accurate and more efficient treatment of the patient, with a qualitatively better outcome. The principle is widely used in radiological ultrasound and obstetrics.

Cardiology

Simple cardiology examinations are now decentralised, and only the more extensive examinations are present at regional and university hospitals. Therefore a wider use of telematic and automatic solutions, including teleconferences, will be necessary to achieve qualitatively good health care. For many patients, these evaluations will result in treatment with pharmaceuticals or via surgical means.

Echocardiography

In smaller hospitals or in primary care less skilled personnel can evaluate the patient, but for a proper evaluation more skilled personnel ought to be used to determine future treatment. For this reason telematic solutions are a must when implementing change in the delivery process.

Pacemaker controls

In the regular control of implanted pacemakers special equipment, supplied from the individual manufacturer, make it possible to transfer data and information over the Internet (or VPN) for evaluation of the individual patient.

Acute Electrocardiogram

In several regions the use of 12-lead ECG monitoring in ambulances is common. This monitoring improves immediate knowledge of ischemia of the heart, which makes it possible to determine if pharmacological treatment should be started immediately or if the patient should be a candidate for coronary angioplasty PCI treatment.

Distributed Radiotherapy

The incidence rate of cancer will increase the number of patients who must be submitted for both curative and palliative radiotherapy treatment. Due to the fact that many patients have long distances to travel, and to a lack of personnel with knowledge of radiotherapy, telemedicine will help to solve some of these problems. Radiotherapy equipment will be situated in one place and the specialist knowledge in another. Several databases and other information sources such as simulating techniques must be connected in order to plan and complete a successful treatment. In the future it will perhaps also be possible to steer the radiotherapy equipment from a distance.

Consultation/Second Opinion

Consultation and second opinion will be available immediately on line with telematic and informatic solutions when needed. The demand for second opinion will also increase due to the pressure of demand and the education level of the general population. In the area of consultation/second opinion good experience has been demonstrated in the following areas:

- Regional rounds in leukaemia, ovarian cancer, breast cancer or other cancer treatment.
- Talk therapy for anorexia/bulimia
- Dermatology
- Speech therapy
- Surgical planning
- Vascular conferences

Internet based decision support system in heart infarcts

Neural network techniques have been developed for decision support systems in heart infarcts. A decision support system has also been developed for treatment of hypertension based on Guidelines (e.g. NIH), which will decrease the cost of pharmacological treatment.

Net based videoconferencing

Videoconferences have been in trial use for years. In a process of changing the delivery of health and social care they will come into more general use. There will be more widespread use of videoconferencing when IT technology emerges from using specialised networks such as ISDN to wide area network. Videoconferencing will then be used for medical conferences, educational purposes or administrative use.

Competence development and education

In order to increase the development of competence in the form of basic education and extended education, there is prerequisite for storing video programmes on servers for later, on-demand distribution of lectures on demand to complement real time sessions.

Standardised Use Of Medical Devices In Hospitals For Diagnosis And Treatment

In order to strengthen strategic competence in clinical engineering and IT (including telecommunications), networks should be established between these specialities regionally as well as nationally and even internationally. In the future, the university hospitals must have a more established network for development of new ideas and technologies for preventive maintenance and heavy investments in devices.

Home Care, Transfer Of Medical Care And Devices From Hospitals

When taken into account the ageing population and the general trend of changing attitudes, more people will be taken care of in their homes. A prerequisite for this assumption is that, in the future, supportive care can be given at a distance by utilising modern telematics. Physical closeness between health care professionals and the individual person is not always necessary for a consultation. In the future, individuals will more probably demand higher competence and quality of care.

This means that health care in the future will be more focused on the patient, and more knowledge oriented. Comparison of clinical results will lead to development of new techniques with more effective resource utilisation. The current models for organisation must therefore be changed and high technology solutions will have to be used also in a smaller format; i.e. home care.

Mobile monitoring

Mobile communication using 3G and GPRS techniques will find further applications in monitoring of medical variables, in concert with companies developing mobile devices for communications.

Monitoring and video communication

Telemedicine in home health care will focus on development of integrated systems for telematic and informatic support in the individual's home, supporting health as well as social care. The gain will be a more secure situation for the patient as well as for relatives, but also that the information is available for medical and social professionals when needed.

Medical devices for information transfer

Suggestions of importance for the information transfer from the patient's home in order for the medical professional's to take decisions on further treatment. The information can be transmitted to a physician, a nurse or to the social care provider for a decision on the right level of treatment.

- Video communication
- Monitoring of the heart, ECG, ultrasound
- Monitoring of blood gases
- Monitoring – registration of brain activity (EEG) at epilepsy
- Monitoring of respiration
- Registration of blood glucose
- Detection of movements

Devices placed outside the health care provider domain must be safe and simple to use. Instructions for handling the devices must be simple enough for safe handling by personnel, relatives or patients.

Primary health care is a natural part of home health care, but it must be noted that primary health care will be supplied with more sophisticated medical devices in the future, and will also submit and transfer information to other health care providers.

A suitable infrastructure is a prerequisite. IT solutions must also be further standardised. Other important factors are that the information transfer is effective and that there are medical professionals present to take care of the information. This means that the present organisational structure must be changed and further developed.

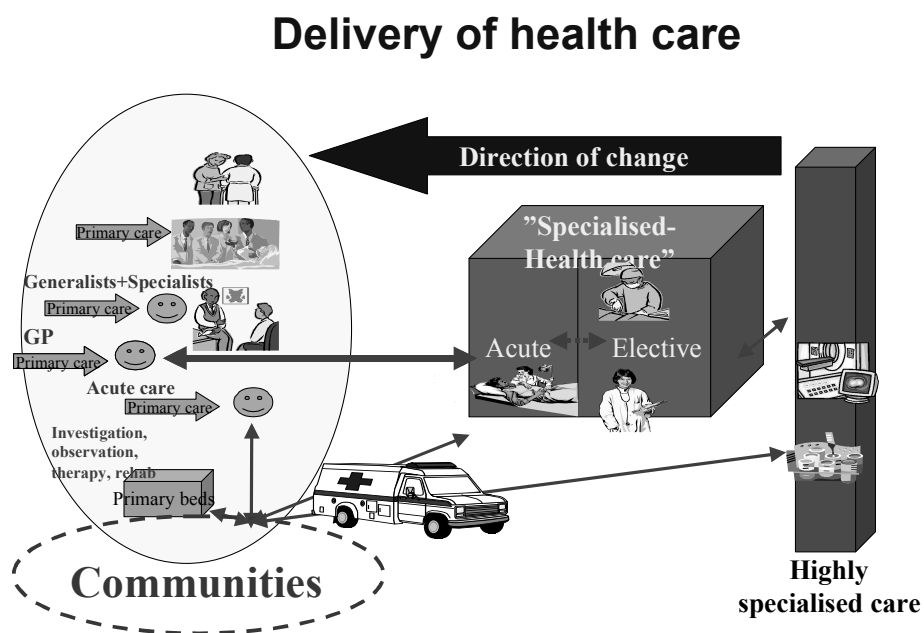


Figure 1: Delivery of health care

Information And Telematics Support

Different actors and different information structures are present in health and social care. In order for health and social care to be able to change and develop their efficiency and quality, demand for having the right information at the right moment and at the right place will increase. The record systems must be available for the medical personnel who need the information. The record will have to not only contain written text but also laboratory answers and information from different image modalities, as well as other multimedia information such as heart sound.

This means that the organisational structure of the health and social care provider must be changed and developed. The demand for availability of personnel will increase. Juridical aspects for the availability of information must also be enlightened in order to develop secure and safe use of patient information.

Different interest groups

The interest groups for patients with diabetes, kidney disorders, heart and vascular disorders, cancer, CF, etc. is expected to further influence the development of future health and social care.

Conclusion

This report concludes some points of utmost importance for the development and use of telematic and informatic solutions in future health and social care.

We need:

- More and better integration of clinical engineering and IT with their products and services.
- To develop different standards for medical devices and patients' records and also propose what standard should be used for communications (e.g. HL7, DICOM, IHE etc).
- To support the technological development of primary care and home care.
- To stimulate consultation between professionals.
- To develop net-based guidelines for health care recommendations.

Different telematic and informatic applications can enhance future health and social care. Networking between medical professionals on different health care levels will increase safety, quality and availability of care. The medical specialist will be present when needed.

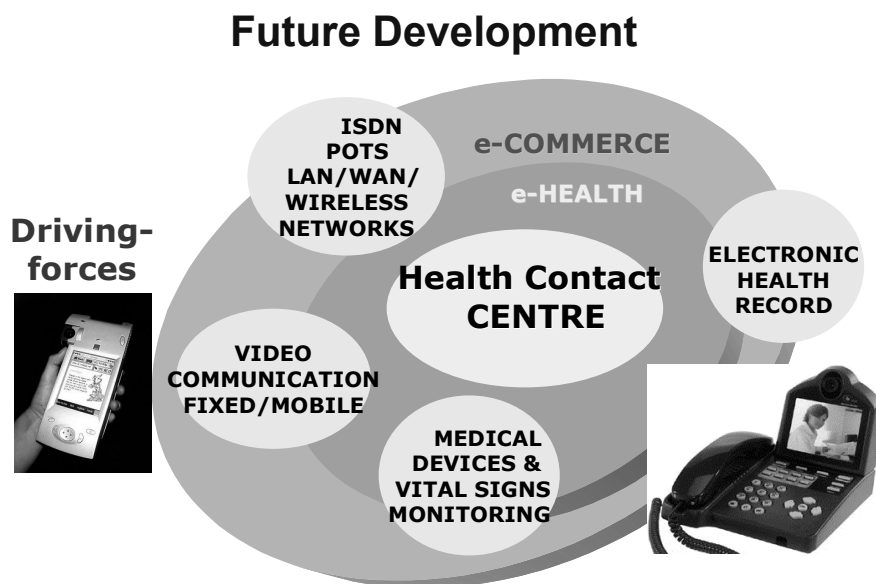


Figure 2: Future development