Current Trends and Difficulties in Knowledge-Based e-Health Systems

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Abstract. discussion on matters arising from encountered problems while designing and introducing e-health systems is presented in this paper. In particular, some difficulties in the adaption of ICT to e-health systems have been emphasised. Additionally, the future vision of healthcare evolution by means of information technology is analysed. Questions which arose as to the main challenges for healthcare systems were both technological and non-technological.

Keywords: e-health, e-healthcare system, medical information system, knowledge-based system, telemedicine, electronic medical record (EMR), electronic health record (EHR).

1 Introduction

E-Health is facilitating access to healthcare by utilising Information and Communication Technologies (ICT) tools and services for health. E-health refers to structured and managed services including: electronic health (medical) records (EHR / EMR), telemedicine (telehealth), Healthcare Information Systems, mHealth (mobile health), Connected Health. Also a new term emerged from e-health in terms of web 2.0 services: health 2.0.

Despite the economic downturn, the use of ICT services, such as mobile phones and the Internet, continues to increase worldwide (Fig. 1) [1]. High-speed mobile Internet access in an increasing number of countries will further raise the number of Internet users, especially in the developing world. It may break the barrier of high quality of data traffic medium and from an e-health viewpoint - medical services would be available for more and more people worldwide.

Medical information systems involve subsystems containing among others patient information, reporting tools, decision support systems and clinical scheduling. Due to the highly complex and enormous nature of collected medical data, medical information systems should comply with basic and well-proven trends of data management. It considers all available medical resources in context of data acquisition, storage, retrieval and further processing and utilisation. As acquisition, storage and retrieval of data are providing only the platform for operational activities, the major focus on knowledge-based e-health systems should deal with extended processing, analysis and reasoning. The basics of such operations include

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functionalities providing reporting and data mining analysis. As presented in Fig. 2, information systems overall should be extended with new abilities incrementally. Knowledge-based systems benefit mainly from advanced data mining tasks: statistical analysis, extraction and prediction.

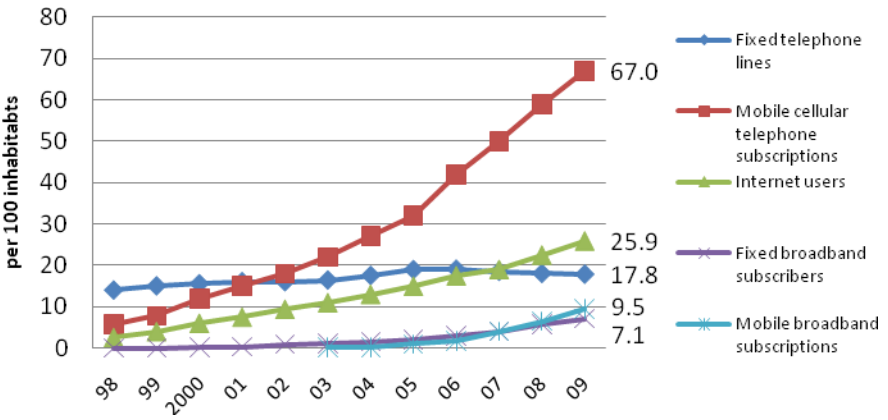

Fig. 1. The mobile miracle, based on ITU World Telecommunication/ICT Indicators database [1]

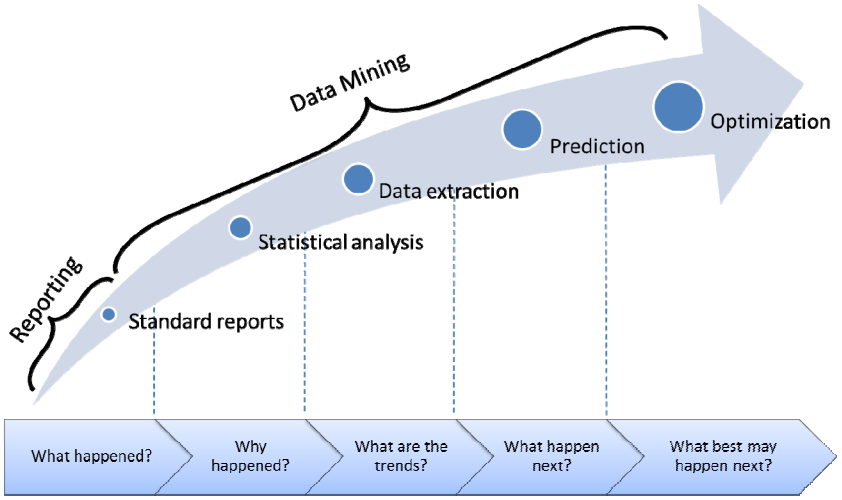

Fig. 2. The stages of knowledge-based information systems maturity

We can distinguish a range of services that combines contemporary ICT from traditional methods and delivers:

1) technologies supporting patient self-care and necessary education,
2) patient-provider and provider-provider communication,
3) electronic data storage and data sharing across providers,

4) systems that support decisions made every day by doctors and nurses, pharmacists,
5) technologies that combine all of the applications above [2].

Finally, there is growing awareness of the importance of evaluating the use and impact of information systems. Both barriers and facilitators exist regarding the successful implementation of e-health services.

2 Difficulties

Nowadays we can note a growing pressure to provide management information, control operating costs, facilitate quality management and improve patient safety. The Institute of Medicine estimates that about 98,000 deaths occur each year due to medical errors [3]. Lyytinen and Lyytinen and Hirschheim in 80' reported a 50% failure rate for information systems with a suggestion that technical problems were the underlying cause [2].

The success of implementation and utilisation of knowledge-based systems depends on integrating the computer system into a complex organisational setting. The assessment of organizational environment is based on a measure of technology compatibility which plays an important role in the adoption of ICT. Also any errors made in the transition to new technologies are less acceptable in sectors other than healthcare (severe and irreversible consequences). In spite of technical problems Lyytinen and Lyytinen and Hirschheim enumerated several causes of failure in information systems implementation. Mainly these are: problems with format and content of the data, user problems related to skills, competence and motivations [2, 4]. They also mention organisational difficulties. For example, in the United States the electronic medical record (EMR) which stores health information to assist health professionals with decision-making and treatment, was used by only 20-25% of physicians in the ambulatory care setting, and by only 5% of all hospitals for computerised treatment entry, while in the UK and New Zealand this rate was above 50% [5, 6].

Evaluating information systems requires not only an understanding of computer technology, but also an understanding of the social and behavioural processes that affect and are affected by usage of e-health applications that changes people's lifestyle, e.g. in attitude towards healthcare and in technology readiness [7].

3 Trends

Current visions of innovation in healthcare systems identify both an approach to join different technological sectors as well as the need for technological platforms. Main technological challenges include bioinformatics, DNA/protein sensors, self-powered micro and nanosystems, standards and interoperability [8], and furthermore, data protection, enhanced security, where more than one layer should be covered by the security mechanisms in order to achieve high quality protection of the e-healthcare system [9].

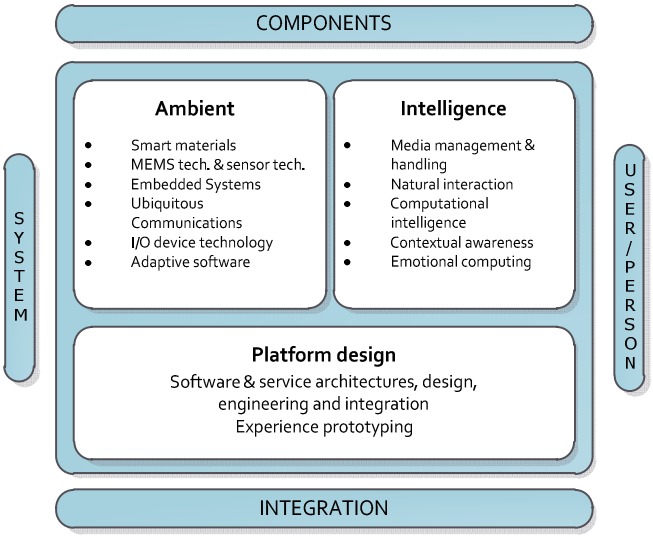

Fig. 3. Technology research requirements for AmI based on [8]

One of the topics that have so far received much attention is the creation and development of the/a patient personalised interface. It uses Medical/Patient/Health Records (EMR, EPR, EHR) which should be always available for processing and protected from unprivileged access. These will have to be accessible from mobile devices. It is for this reason that modelling medical records and simulation of complex systems need to be performed. This is crucial because EMRs can provide lifelong clinical information and can be used by professionals. They should be coordinated with the help of applications such as calendars for event-planning and communication services, and in fact all activities around patient management.

Another point to be discussed is knowledge management. An ongoing challenge is how to integrate standalone information repositories into a single logical repository.

Also non-technological challenges have to be solved. For example, the equal participation of users needs to be ensured [5]. A holistic approach to the non-technological aspects concerns aspects affecting society at large and healthcare systems in particular, e.g. political commitment, financial resources and liability of healthcare providers [10]. By way of illustration follow the case of Thailand [11].

One of the proposed ideas in Europe is that of Ambient Intelligence (AmI) designated for information society where the emphasis is on user-friendliness, efficient and distributed service support, and support for human interactions will allow healthcare to go beyond the simple provision of e-doctors [10]. The value of any ICT is fundamentally linked to the ability to share that information and connect with other users. These ideas are included in the European concept of AmI:

> "The 'Ambient Care' environment is a responsive and proactive environment that enables easy participation of the individual in their own healthcare management, including communication with professional carriers, friends, family and the wider community. It will enable remote monitoring of activity and physical well-being and will include people with physical disabilities" [8].

There are a number of research domains for which significant progress is expected in order to develop further and realise the AmI vision (Fig. 3). For instance free software and open source endeavours in e-health should be encouraged by authorities. Besides, there is a need to share knowledge and find methods to evaluate the impact of investments [12].

Nowadays development of e-health services is also aimed at GRID-based applications and technologies around Geographic Information Systems working with location-based services [13]. In this context data mining and expert systems are used for knowledge extraction.

4 Conclusions

The healthcare sector is increasingly becoming a knowledge-based community that depends fundamentally on knowledge management activities to improve the quality services. As outlined in this report, a systemic approach to innovation in e-health needs to be connected with a holistic approach to the non-technological aspect. E-health will facilitate the provision of information at the right time, and support decision-making and knowledge management when making diagnoses. In parallel with these processes the development of a common open source base should take place. The objective of future endeavours is to integrate processes of normalisation by working on standards, paying attention to enabling ICT knowledge transfer by diminishing organisational and financial obstacles.

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