Electronic Health Services
An Introduction to Theory and Application

Mounir M Khalil[1] and Ray Jones[2]
(1) Programmer, webdesigner and medical student, AlFateh University, Tripoli, Libya.
(2) Professor of Health Informatics, School of Nursing and Community Studies
University of Plymouth, Plymouth, UK..

Abstract: Information and communication technologies have made dramatic changes in our lives. Healthcare communities also made use of these technologies. Using computerized medical knowledge, electronic patients' information and telecommunications a lot of applications are now established throughout the world. These include better ways of information management, remote education, telemedicine and public services. Yet, a lot of people don't know about these technologies and their applications. Understanding the concepts and ideologies behind these terms, knowing how they will be implemented, what is it like to use them and what benefit will be gained, are basic knowledge steps approaching these technologies. Difficulties using these services, especially in developing countries should not be neglected or underestimated.

Key Words: *electronic health services, ehealth, telemedicine, health informatics, electronic health records.*

Introduction

Information plays a major role in the practice of health at all levels. Information collected from scientific sources, patients, colleagues, administrators and personal experiences are all used in medical practice. The way these informations are handled, stored and shared influences how effective and efficient they can be.

Health informatics helps doctors with their decisions and actions, and improves patient outcomes by making better use of information. This is achieved by improving the ways patient data and medical knowledge are captured, processed, communicated, presented and applied.[1] Figure 1

During the last two decades, information and communication technology has made huge progress rendering the world to a small village. A lot of e-terms (e for electronic) have been and are still emerging as these technologies are getting more and more implemented in our everyday applications. E-trade, e-mail, e-commerce, e-government, e-company, e-journals are few examples.

The new era of health informatics includes terms such as e-health, e-medicine, telemedicine, electronic health services …etc…There is considerable overlap in the use of these terms, and many of them can be used in an all-fit-for-all manner. [2]

Methods and Materials

The data were collected from medical literature about health informatics, electronic health services and telemedicine; theories, researches and trails. Best effort was made to access the up to date contents on every topic.

Figures 1 2, 3 and 7 were designed upon self experiences and information from the literature. Constructing the article aimed at introducing the concept, explaining the wide range of services and pointing out the main pros and difficulties implementing such technologies in health. The current situation of the developing countries regarding ehealth was also discussed in brief.

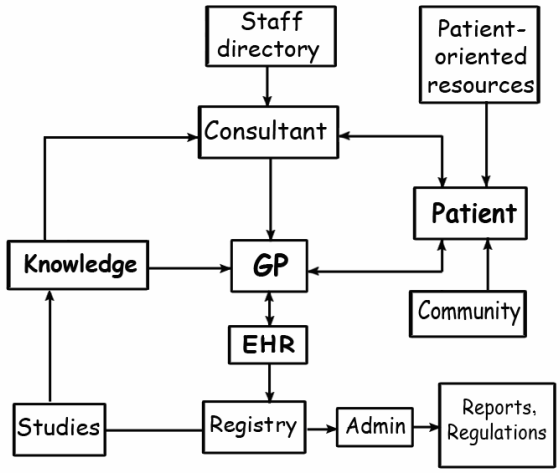


Figure 1. Information traffic in a healthcare system.
GP: general practitioner, EHR: electronic health records

What is e-health?

Although e-health can simply mean "using the computer-based technologies in the health profession practice", defining "e-health" is just like trying to define the word "internet", there is no precise agreed-upon definition. It is a universal term, not confined or limited to a particular concept, but simply implies a medico-technological coupling at the level of informatics. It can be thus regarded as a mother word. More than 50 definitions for e-health are now indexed in Medline and other scientific indices.[3] This is further complicated by some scientists arguing that e-health is not a scientific term, and that it should be used only by businessmen not academics [4]. One of the most accepted definitions [3] is Eysenbach's;

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and

related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." [4]

Computers are advantageous in having huge storage capacities, ultra processing capabilities and a wide range of connectivity. Human thought processes can be complemented by strengths of electronic tools,[5] thus, electronic archiving plays a central role in establishing the electronic health system, from small clinics up to national [and international] levels. Electronic archiving is becoming an integral component of healthcare services and in many industrialized countries it is replacing traditional paper-based system. [6]

Processing information in electronic records is done on many levels. Figure 2

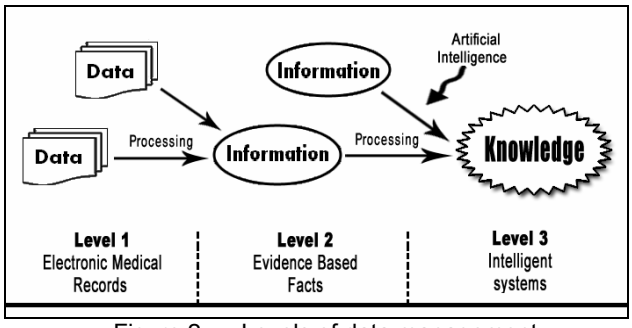


Figure 2. Levels of data management

Electronic Health Records (EHR)

Also called electronic medical records (EMR), this is a longitudinal record of personal health and healthcare "from cradle to grave". It combines information about patient's contacts with primary health care as well as subsets of information about hospitalizations [secondary and tertiary healthcare]. Figure 3 The term electronic patient record refers to records of patient healthcare provided periodically by one institution (a hospital for example). It represents the classical file for every patient admitted to a hospital. It is a part of this patient's electronic medical record.[6] In simpler terms, EHR or EMR is one's health history (oriented to one person), while the EPR is oriented towards the services provided by a healthcare provider to its costumers.

Thus defined, an EHR is able electronically to collect and store data about patients, supply that information to providers on request and permits physicians to enter patient care orders on the computer, this is known as computerized physician-order entry CPOE.[7]

Hospital Information System (HIS)

The integration of electronic patient records with other databases like pharmaceutical work, administration informations, schedules, financials, peripheral services in a hospital is part of the Hospital Information System HIS.[8] Further technology allows remote access to the HIS through mobile devices [portables, PDAs, mobile phones] and using network remote access through LAN, WAN or internet. [9][10] This is the core of what is now known as the "paperless hospital". [11]

Data feeding

While human brains are able to analyze and extract informations from free text (comprehensive data), computerized devices have limited ability. The electronic records should be therefore fed to the electronic system [computer, laptop, handheld device] via a special protocol to render these data *understood* by the computers. This is called coding and classification, there are many systems for this; the most globalized system is the *systematized nomenclature of medical and clinical terms* SNOMED-CT system. [12]

These are very technical details, physicians will use the interface provided by their EMR software, and they will continue their work in their regular language, with a range of input devices such as keyboards, touch screens, handwriting recognition systems and voice recognition systems.

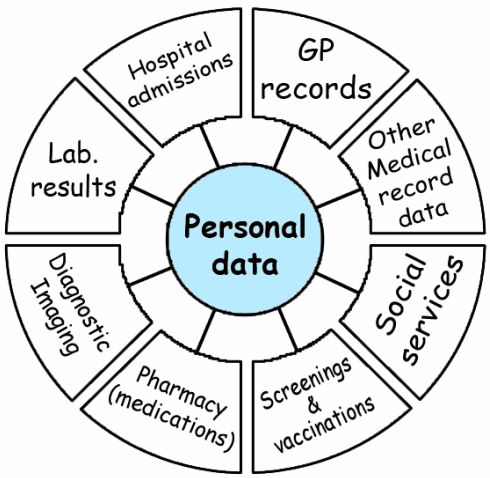


Figure 3. Components of an EHR

Data interpretation

The digital nature of the electronic medical records enables a wide range of presentation formats and a wider range of usage. A single variable, blood pressure for example, can be displayed in different ways; a raw number *(180/110 mmHg*), in words (*High blood pressure*), a colour

coded alert, in a table or as a point on a graph. [1][12] *Figure 4*

Knowing more about a patient from his records reduces consultation time and effort and increases the compliance, as the patient will not have to repeat the "whole story" again, and the physician will not have to repeat the whole examination and investigations. Single investigation results are often less informative than serial value-changes that gives a discernible pattern. Archived images are more likely to be available than a film, and serial display of them will facilitate comparison.[13]

Electronic records present information on past problems as well as the current complaints, some relevant data may not be as easily identified on the summary sheet as they will be on a screen.[12] They also eliminate memory bias and relevant data-loss, especially in elderly and chronic-diseased patients. Today in the United Kingdom, the quality and outcomes framework of the general medical service relies heavily on the electronic processing of coded health data. [14]

Data sharing

If information needed is not available in the right time and format, they will be costly or useless. Complete and accurate data recording becomes more important when a different member of healthcare team needs to know what information is already known or deduced about the patient.[5][6]

The sharing of electronic medical records between different healthcare providers is essential for reading and updating them. The digital nature of these records enables them to be shared early, easily and cheaply.

In the United Kingdom, general practitioners tend to have the most comprehensive record including information sent from hospital records. The long term intention of current work is to provide a single EHR.[15] In other countries, such as USA, EHRs are made available on a smart card, which is now being used by many hospitals. Sub dermal devices called “VeriChip”, were also made available, but are not as well accepted as smart media despite FDA approval due to ethical and medical reasons. [15]

Effective integration of EHR depends on establishing a workable unique personal identification system such as the community health index number CHN^{o} [6][16] and the National security number used in the United Kingdom.

What data to enter, for how long should it be kept, with whom should it be shared, how and when? Such issues and more have to be clear in dealing with EHR. This is covered by strict security protocols and predefined access levels according to a list of rules and restrictions.

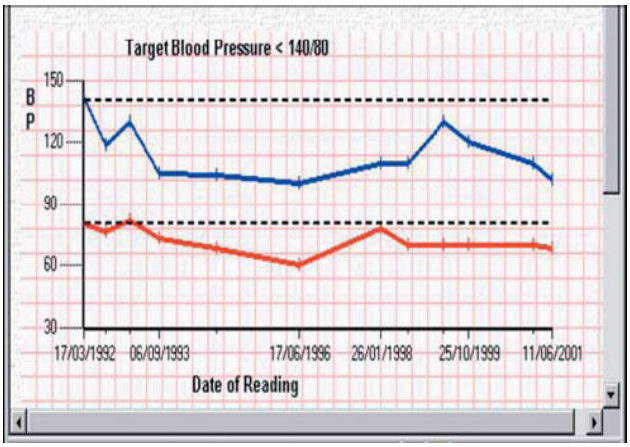


Figure 4. 9-years cumulative recording of blood pressure [1]

Side services

The presence of an electronic version of medical records enables the physicians to regulate their working times, schedules and self-prepare for patient contact, (for example by reading his medical record, searching for more data or read about a new drug).

The presence of a computer and internet access in the clinical environment facilitates, with some regulations, access to online medical literature, e-journals [17], clinical guidelines and patient education materials. [13] Networking also facilitates physicians contacting each other, their patients or their seniors; these are some forms of *telemedicine*.

Evidence based Medicine EBM

EHR are valuable sources of information; applying statistical studies on them is very cost-effective, as they are already collected. Their digital format enables them being easily analyzed and computed. The disadvantages of retrospective studies (bias, archiving errors, lost data) and those of prospective studies (time, effort and cost consumption) are brought to minimum, allowing wider scale studies to be performed with more accurate and reliable results.

EHR make most of the service automated, and most information is ready-on-demand.

Evidence based medicine is the integration of clinical expertise with the best available external clinical evidence from systematic research.[18] The outcome of this processing is an unlimited number of evidence-based facts about all steps of healthcare providing that is useful in all levels of healthcare service providing.[16][18][20]

Intelligent support systems

Undergraduate education, postgraduate training and continuing professional development are traditional routes of knowledge. Unfortunately, these

traditional sources are relatively inefficient.[14] Our brains' knowledge stores decay over time and their working memory becomes overloaded. Prompts and reminders at the point of health care are useful aids to an overworked human brain for certain tasks.

Intelligent systems, using either artificial intelligence, or sometimes simple rules, can monitor, analyze, and prompt doctors in their decision-making. [21] They can assist less experienced physicians to efficiently make a case-oriented clinical history and examination and guide them through the right protocols. [12]

Future advances in artificial intelligence will allow such systems to support almost all levels of medical practice, from clinical work, establishing diagnosis (computer aided diagnosis **CAD**) [22] to health administration guidelines and decision-making.

Some health professionals are worried that using such electronic aids may reduce patient's trust in physicians, but research evidence is to the contrary. [12]

Public services

As the internet culture invaded the public consciousness during the 1990s, the internet, being an unprecedented source of information has been used as a health-education and knowledge-dissemination tool.

People who have health-related concerns have the motivation to seek knowledge related to their concerns, if they are satisfied, they could even avoid a consultation. [16] During year 2000, 30 million people in USA went online for health-related materials. [23]

Today, searching for a disease (on Google for example) would return in a few million pages in less than half a second. [17] These include online advices, educational programs, patient-oriented health portals, direct or mediated (simplified) medical literature, or some sorts of telemedical services. Health-related internet public services provide a wide range of services that include Consumer information services, online support groups and online medical advice and diagnostic services. [14]

Consumer information services

These provide general health and wellness information for general or targeted population e.g. women, elderly, cancer patients, etc. They are expected to provide well-chosen, scientific, patient-oriented up to date data. The American Cancer Society website [25] is an example, provides a wide range of contents for cancer patients. Some physicians provide explanatory materials in their personal websites. Explanations in the form of diagrams, images, and videos are often simple and appreciated by patients. Other more detailed [anatomical and pathological] explanations can be also provided.[12]

Online support groups are community websites providing a virtual lodge for psychological support, shared patients' experiences and open discussions. These are very popular but only a few are moderated by health professionals.

Medical advice and diagnosis services

These provide a more interactive service, under health professionals' supervision. Answering specific questions submitted by site visitors, dealing with individual cases, booking for a consultation etc. A lot of practitioners now provide this service from their personal homepages or over e-mails. [26][27][28] This is considered as one form of telemedical patient consultations.

Some websites provide contract-health services for specific patient [or set of patients] that are covered by an insurance plan or are employer for a covered institution.[24][29] Other sites provide over the counter or prescribed medication sales, with other medical products that can be delivered by physical mail. These services can take any form that the online and computer technology can provide.

What is telemedicine?

According to the American Telemedicine Association ATA, telemedicine is "*the use of medical information exchanged from one site to another via electronic communication for health and education of the patient or health care provider and for the purpose of improving patient health status.*" [30]

Telemedicine is thus, from definition, covered by the term e-health, but it has a special category because of its semi-dependence and high costs. The above definition theoretically includes simple telephone calls between two physicians, medical TV show, or an interactive medical website. But practically, the term is only applied to more complicated specialized systems (real-time interactive multipoint video-conferencing with application-sharing like Picture Archival and Communication Systems PACS, HL7, Tele-DiCom etc.) [31]

In *asynchronous* or *store-and-forward* system, the information is captured and stored in one side, then forwarded via telecommunications to another site; a good example is the e-mailing system.

In *Synchronous* or *real-time* systems, ideally both the physician and patient [in telemedical language, the healthcare service provider and the costumer] can hear and see each other (video conference), the physician can also access the patient's health file and can deal with a wide range of devices

starting from electronic stethoscope, ECG monitors , up to controlling MRI radiograph systems. [32] *Figure 5 & Figure 6*

This technology has been tested in ICUs and emergency medicine departments too. [33]

Recently, *telesurgery* enables surgeons to operate remotely through robotic systems. [34] Much more applications that are beyond this article are also either available or under trial. [35] [36] This is practiced under the cover of policies, protocols, licenses, and medicolegal supervision, just like regular medical practice (with modifications). [37]

Telemedicine thus consists of four components; [32] *technology* (peripheral devices, computers…etc...), *connection* (internet, satellite…etc...), *people* (physician, technicians, patient) and *protocols* under which they work (medical, medicolegal and technical).

The success of the process depends on the implementation of all the four components in the right manner.

Figure 5. Tandberg Health Care System III

Figure 6. Electronic otoscope and stethoscope.

Forms of telemedical services

The tele-exchange of health information can take many forms according to who is using and how is the usage of this information; Figure 7

Specialist referral service (Teleconsultation)

This typically involves a consultant or a specialist assisting a GP in rendering a diagnosis or treatment. Recent surveys showed a rapid increase in specialties and subspecialties that have successfully implemented the telemedicine in its practice.

On top of all, radiology "teleradiology" comes in place, with thousands of images being read remotely each year. Other specialties include teledermatology, teleophthalmology, telepsychiatry, telecardiology and telepathology. Almost another 40 telespecialties are already established. [32][38][39][40]

Patient consultations

This is telecommunication between the patient himself and a healthcare provider; it is suitable for answering simple questions, follow up treatment etc. This is not used widely but has been successful in telepsychiatry and telenursing.

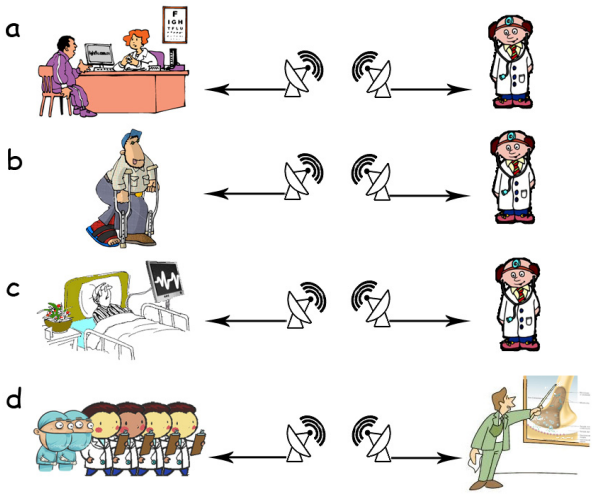
Remote patient monitoring (Telemonitoring)

This includes the usage of electro-medical devices to collect and send patient's health status data to the health care provider. Such applications are used in "home telemonitoring" for specific vital signs, blood glucose, EGC, peak flow rate, coagulation profile, blood/urine chemistry etc. [12]

Home telemonitoring can improve the follow up of chronic diseases like heart diseases, liver disease and diabetes.

Medical education (Tele-education)

Medical education (Particularly continuous medical education **CME**) has benefited greatly from advances in telecommunication systems, now seminars, conferences, lectures and discussion groups can be made in real-time with members all around the world.



a) Specialist referral service, b) Patient consultations
c) Remote patient monitoring, d) Medical tele-education
Figure 7 Some forms of telemedical services

Pros of eHealth Applications

Through the integration of the above applications of e-health and telemedicine, a great change can be made in health practice, with a lot of advantages towards (directly and indirectly) a better and more reliable health care system;

Regarding the patients

For patients, these systems can:

• provide more accurate data about the patient's health file, both for his usage or for the health care provider's.[41][12]

• enable a closer follow up for elderly [43] and patients with chronic diseases.

• facilitate access to specialists. [32]

• provide remote medicine without the costs, time consumptions and patient exhaustion of travelling.

• decrease the end-costs for the patient while provided by a high quality health care. [41]

• provide simple but valuable explanation for the disease, precautions, treatment and complications, in a simple interactive way (images, videos), answering the patient's questions and providing psychological support.

Studies have shown that when primary health care was provided remotely, people were "able to ask more questions, felt better informed, less anxious and more confident." [42][44]

Regarding the healthcare providers (health workers, hospitals, clinics)

The system provides a more professional work environment, scheduling time and regulating the work. The staff will have easy access to medical sources and records, easy search and adequate informations about their patients; this provides a better physician-patient relationship and a more specific management.

Physicians will be able to recognize the pattern of their work, [18] the reliability of drug regimes they prescribe, risk prediction and disease prognosis for particular patients.[12]

The standardization of guidelines and the usage of clinical prediction rules [derived from the patient case] assist the physician to improve the expected outcomes.[5]

Teleconsultation, CME, virtual conferences, up-to-date materials will all be a matter of minutes.

The staff will also have more secure medicolegal coverage, through predefined working protocols. Overall increase in work efficiency "Do less for more".

Regarding the healthcare organizers

New health informatics tools typically improve effectiveness by 10-15%. In the USA it has been estimated that in 2003, they saved about $120 billion by using health information systems. [5] These systems:

• provide efficiency, real costs and enable fast error detection and management.

• allow wide scale biostatistical studies through the nation-wide health records, providing evidence-based medical facts at relatively low costs.

• allow wide-scale screening tests in a controlled fashion with accurate results and low costs. [Primary prevention]

• serve as a hot-line network in disasters, reorganizing teams and minimizing "paralysis" that occurs in such conditions.[35][45]

• enable communication between all health departments, conferences, seminars etc.

• enable high-quality medical services in rural areas and peripheries at low costs.[46]

• decrease total health costs at many levels [decreasing errors, travel costs, communication costs, preventing diseases, remote education] and shifts more resources towards the patient and community, without decreasing health service quality and probably improving it.

• help deal with staff shortages or requests for improving working lives (like working from home). [47]

• could help in moving towards services that are better coordinated, promote equity and patient independence and adhere to government targets on national and international levels. [47]

Obstacles to establish electronic health systems

According to the National Health Information Network, over the past few years, as many as 30% of e-health implementation attempts have failed. There is a long list of difficulties that face establishing e-health systems, the following represent the main issues;

The third partner concept

Rather than the classical patient-physician process, a list of persons and tools will be added; technicians, engineers, computers, peripheral devices, service providers, software inputs and others, representing the third partner "technology". Health administrators will not be the only decision-makers and they will have to discuss all details with the new partner. This can be inconvenient or even annoying.

Medical secretary and health technician are new specialties and can partially overcome these troubles by acting as mediators between the "health" and "technology".

Adoption of e-health appears to be limited by cultural and attitudinal inertia, and resistance to behaviour changes within the healthcare system. [48][49] Health-advice seeking behaviour in people and healthcare practicing in health professionals have to be modified to maximize the benefits of the electronic health system.[6]

Depending on a third partner also, increases the risks of whole system malfunction, computer breakdowns, software bugs, networking troubles, security issues and compatibility are few troubles

that could result in disasters if not managed before they occur.

Financials

Although e-health systems are not “buy and play” sets, their initial costs can be troublesome for a lot of healthcare systems despite them being cost-effective at the long term. While the cost of technology continues to plunge, it is still beyond the reach of many.

Infrastructure, hardware, software, installation and maintenance of the system on one side and operating, training, and hiring staff on the other, contribute to high costs that may be unaffordable for the limited funding provided for health sectors.

Health system status

Implementing these technologies in a health system with no (or poor) guidelines is just like driving a car in streets with no traffic lights. firstly, the practice should become objective (protocol-based) rather than subjective (sense-based), through many strategies, this will directly improve the outcome, even before computerization.

Education

Electronic health services are backboned by minds not by computers. Extensive implementation of computer technology in the health field needs trained staff. Apart from technicians and operators, all medical and paramedical staff should have minimally a basic level of knowledge so that they are not prevented from using the service. Education empowers physicians and the public to start using the electronic services provided for them. This is one of the complicated issues; time, effort, and money are to be spent, but the compliance of the staff remains a tough barrier on many occasions.

Medicolegal concerns

Shifting from paper to paperless work and electronic recordings in medical field requires a similar change in the medicolegal laws and practice. The issues of insurance, malpractice, medical responsibility and work-threatening technical error should be all supervised and regulated by e-health law.[50] Another dilemma is the evaluation, filtering and regulating the online content provided to the public. Licensing the telemedical practitioners is needed too. This is further complicated by the need for regulatory technical standards (security, access, identification and policies). [51]

Sharing electronic health records for epidemiological research, statistics or studies needs the patients' agreement ([and maybe consent) on who and how will use it . This should be performed under strict regulations and supervision. [16]

Developing countries and eHealth

Developing countries are facing dire health crises due to lack of basic health services. Major threats to public health stem from a shortage of health professionals, health education and out of date clinical practice.

Although information and communication technologies cannot solve these problems single-handedly, they have the potential to improve the healthcare status of these countries by delivering informations and services from developing countries over political boundaries to developing countries. Trials involving teleconsultations [51] and remote education [53] showed promising results. These technologies also create an internal infrastructure that ensures maximum benefit from these imported informations. [54] This targets both healthcare providers and the public.

It may come to a point where there is a globalized health system based on the dissemination of health knowledge everywhere equally and effectively using the information and communication technologies.

Delivering ehealth to developing countries faces different health and socio-economic challenges to developed countries. [54][55] There are a lot of issues to be considered; will developing countries, with their developing economic system, pay for “basic” or “electronic” health services? What is the value of up-to-date health informations in the absence of abilities to implement them? And are information and communication technologies efficient means of improving public health knowledge and wellness when infrastructure, literacy, language [56] and other factors limit effective access these technologies?

Ready answers are beyond the scope of this article, and probably not ready anywhere soon,[56] but it is to state that some established projects aiming for health information delivery from developed countries are being developed, a good example is the Euro-Mediterranean Internet-Satellite Platform for Health medical Education and Research **EMISHER.**[57]

Overall performance

Changing the way of medical practice, introducing a new partner in the health sector and modifying the laws under which it works, with a high cost of money, time and effort seems a tough equation versus performance, while the main goal of e-health is increasing the performance.

On the other hand, worldwide experience in these projects proves that the right way of implementation gives promising, outstanding results. [9][44][58]

Conclusion

Better information management in the health field can dramatically upgrade the process and improve the outcome. E-health is an already established field with a lot of applications worldwide. It is the future of health practice and, sooner or later, it will become a mandatory partner in the health systems all over the world. Advances in ideas and inventions in this field are making very good progress and a lot of useful applications are being added every year. Public health education and assisting them using these technologies is another key for improving the community health status with low costs.

Despite the critical status of health services in developing countries, electronic health services can participate in raising the quality and availability of health care services.

Apart from the high initial costs and tough obstacles implementing these systems, outcomes are satisfactory and rewarding, provided the system is implemented in the right way.

References

1) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; What is health information? *BMJ* 2005; 331:566–8

2) Waegemann, C. Peter (2002). "Status Report 2002: Electronic Health Records" . Medical Record Institute website www.medrecinst.com/uploadedFiles/MRILibrary/StatusReport.pdf

3) Oh H, Rizo C, Enkin M, Jadad A What Is eHealth (3): A Systematic Review of Published Definitions J Med Internet Res 2005; 7(1) www.jmir.org/2005/1/e1

4) Eysenbach G, What is e-health? J Med Internet Res 2001; 3(2):e20 www.jmir.org/2001/2/e20

5) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; How computers help make efficient use of Consultations. *BMJ* 2005; 331; 1010-1012

6) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; How decision support tools help define clinical problems. *BMJ* 2005;331;831-833

7) Blumenthal and Glaser. Information Technology Comes to Medicine. Eng J of Med; 356(24):2527

8) Kazuhiko Ohe ,Shigekoto Kaihara ,Koichi B. Ishikawa et al. Hospital Information System and the Internet , Internet society publications www.isoc.org April 30, 1995

9) Menachemi N, P. R., van Durme DJ, Brooks RG. Examining the Adoption of Electronic Health Records and Personal Digital Assistants by Family Physicians in Florida. Informatics In Primary Care 2006; 14(1): 8

10) Dr George A Brox, Janis L Huston. Mobile Access to eHealth Information Using Entertainment Technology, E health Int J 2007; 3(1)

11) R. H. R. Harper, K. P. A. O'Hara , A. J. Sellen and D. J. R. Duthie, Towards the paperless hospital? British journal of anaesthesia 1997; 78:762-767

12) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; Why is this patient here today? *BMJ* 2005; 331:678-680

13) Jeremy C Wyatt and Frank Sullivan *ABC of health informatics*;. How computers can help to share understanding with patients. *BMJ* 2005; 331:892-894

14) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; Referral or follow-up? *BMJ* 2005; 331:1072-1074

15) Katherine Albrecht, Liz McIntyre. Spychips : How Major Corporations and Government Plan to Track Your Every Move with RFID. Nelson Current, 2005 ISBN 1-59555-020-8

16) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; Improving services with informatics tools. *BMJ* 2005; 331:1190-1192

17) Jeremy C Wyatt and Frank Sullivan. *ABC of health informatics*; Is a consultation needed? *BMJ* 2005; 331:625-627

18) Glossary of terms in Evidence-Based Medicine. Centre for Evidence-Based Medicine. Available at: www.cebm.net/glossary.asp

19) O Steichen, C Daniel-Le Bozec, J Charlet et al. Use of electronic health records to evaluate practice individualization. A*MIA Annu Symp Proc.* 2006; 2006:1110

20) David Joos, Qingxia Chen, James Jirjis et al. An Electronic Medical Record in Primary Care: Impact on Satisfaction, Work Efficiency and Clinic Processes. *AMIA Annu Symp Proc.* 2006; 2006:394–398

21) Wellwood J, Johanssen S, Spiegelhalter Dj ; How does computer aided diagnosis improve management of acute abdominal pain? Ann R Colle Surg Engl 1992; 74:40

22) Hall, F. M. (2007) Breast Imaging and Computer-aided detection. New Eng J of Med 356:1464-1466

23) A Guide to E-Health for the Healthcare Professional: An introduction ATA website www.atmeda.org/ehealth/guide.htm

24) Struber, J; An introduction to telemedicine and email consultations. The Internet Journal of Allied Health Sciences and Practice, 2004. Vol 2 Num 3.

25) The American Cancer Society at www.cancer.org

26) Badal P. Email contact between patient and doctor. *Bmj.* 1999; 318:1428.

27) Spielberg AR. On call and online: sociohistorical, legal, and ethical implications of email for the patient-physician relationship. *JAMA. 1998;* 280(15): 1353

28) Spielberg, AR. Doctor, You've Got Email. (Letter to the Editor). *JAMA*. 1999; 282(8): 729.

29) Knapp, JE. Setting limits is the key to working online. How far should you go in talking to patients looking for advice at your Web site? American College of Physicians - American Society of Internal Medicine, April,1999; available at: www.acponline.org/journals/news/apr99/limits.htm

30) American Telemedicine Association (ATA) Website http://www.atmeda.org/news/overview.htm

31) Todd Dorman. Telemedicine. Anesthesiology Clinics of North America 2000;18; Issue 3

32) Rod Elford, An Introduction to Telehealth. http://www.telehealth.ca/documents.html

33) Brennan JA, Kealy JA, Gerardi LH, et al: A randomized, controlled trial of telemedicine in an emergency department. J Telemed Telecare 1998; 4:18

34) Bowersox JC, Cordts PR, LaPorta AJ: Use of an intuitive telemanipulator system for remote trauma

surgery: An experimental study. J Am Coll Surg 1998; 186:615

35) Garshnek V, Burkle FM: Applications of telemedicine and telecommunications to disaster medicine: Historical and future perspectives. J Am Med Inform Assoc 1999; 6:26

36) Bashshur RL: Telemedicine effects: Cost, quality, and access. J Med Syst 1995; 19:81

37) Arent Fox E-health and Telemedicine Website; www.arentfox.com/telemedicine.html

38) Loane MA, Oakley A, Rademaker Met al. A cost-minimization analysis of the societal costs of realtime teledermatology compared with conventional care: results from a randomized controlled trial in New Zealand. Journal of Telemedicine and Telecare. 2001; 7(4): 226-332.

39) Wootton R, Bloomer SE, Corbett R et al. Multicentre randomised control trial comparing real time teledermatology with conventional outpatient dermatological care: societal cost-benefit analysis. Bmj. 2000; 320:1252-1256.

40) Gustke S, Balch D, West V et al. Patient Satisfaction with Telemedicine. Telemedicine Journal. 2000; 6(1): 5-13.

41) Rod Elford, Telehealth in the Developing World www.telehealth.ca/documents.html

42) Dr Cecilia Pyper, Dr Justin Amery, Claire Crook et al. The Impact of Online access to Health Records for Patients and Health Professionals, International Health Association: eHealth 2003 Conference 16-17 Oct 2003, eHealth International Journal archive.

43) Rashid Bashshur, Global Telemedicine and the Elderly. eHealth International Journal archive, 2007; 3(1):1-7

44) Mair F, Whitton P. Systematic review of studies of patient satisfaction with telemedicine. Bmj. 2000; 320:1517-1520.

45) Aijaz Qadir Patoli, Role of Telemedicine in Disaster Management. eHealth International Journal vol 2 num 2

46) Rajiv Raman, Sheshadri Mahajan, Padmaja Kumari Rani et al. Telehealth Program for Diabetic Retinopathy in Rural South India: A Pilot Study. eHealth International Journal vol 2 num 2

47) Jeremy C Wyatt and Frank Sullivan. ABC of health informatics; eHealth and the future: promise or peril? BMJ 2005; 331;1391-1393

48) Celler B, Lovell N, Chan D. The potential impact of home telecare on clinical practice. eMJA, 1999; 171: 518-521.

49) Coiera E. The Internet's challenge to health care provision. Editorial, Bmj, 1996; 312:3-4.

50) Center of telemedicine and ehealth law. CTeL. More at www.ctel.org

51) Jadad AJ. Promoting partnerships: Challenges for the internet age. Bmj, 1999; 319:761-769.

52) Patterson V, Swinfen P, Swinfen R et al. Supporting Hospital Doctors in the Middle East by Email Telemedicine: Something the Industrialized World Can Do to Help. J Med Internet Res 2007; 9(4):e30
www.jmir.org/2007/4/e30

53) Woo MK, Ng K. A Model for Online Interactive Remote Education for Medical Physics Using the Internet. J Med Internet Res 2003; 5(1):e3 www.jmir.org/2003/1/e3

54) Drury P. The eHealth agenda for developing countries. World Hosp Health Serv. 2005; 41(4):38-40

55) McConnell H. International efforts in implementing national health information infrastructure and electronic health records. World Hosp Health Serv. 2004; 40(1):33-37

56) Tessa Tan-Torres. Disseminating health information in developing countries: the role of the internet. Bmj 200; 321:797-800

57) Project summary. status and aims is available at http://info.emisher.org/project.htm

58) Rod Elford, An Introduction to Telehome Care. www.telehealth.ca/documents.html