E-health quality and key performance indicators

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Abstract

E-health includes a wide variety of health and clinical activities that have traditionally characterized tele-health, tele-medicine, and public health applications which are mainly delivered through the Internet. Even though, evaluation of e-Health has been somewhat disillusioning and not yet evaluated on a large scale. Therefore an assessment required to evaluate all aspects of performance that are important and significant for health care through standardized process, tools, and credited key performance indicators (KPIs). The objectives of the current study are to search for the principle elements of E-health and to develop a criteria for developing KPIs that could be used in their assessment and to draw a roadmap incorporating KPIs with the E- health framework (pillars) on quality dimension bases. Review of literatures was conducted for studies published from 1990 to 2009. Search was run for quality management systems and barriers for E-health success. Criteria of developing KPIs was carried out to fulfill the principles of specificity, measurability, achievability and to be realistic. Fundamentals that were considered in designing included looking forward direction, the level of performance, and the element to be evaluated as well as the concept of accountability. Additionally, the KPIs were designed to be generic allowing future customization to suit diverse health care sectors. Reviewing of literatures revealed variable organizational factors with key barriers to E-health long-term success. Accordingly, there was judgment of four E-health pillars to be assessed including infrastructure, data & knowledge, standards & policy and people. A roadmap was illustrated integrating these five pillars with KPIs. E-health constitutes four main pillars that should be assessed KPIs to ensure the quality of performance. Furthermore, electronic audit is an important part in performance assessment facilitating comparison and sharing data.

Key words: E-health quality, key performance indicators, Health Information

Introduction

E-Health is defined as all forms of electronic healthcare delivered over the internet, ranging from informational, educational and commercial "products" to direct services offered by professionals, non-professionals, businesses or consumers themselves. Further includes a wide range of health and clinical activities that are computer (electronic) based, and/or delivered through local networks or the Internet [1-5]. It is a conceptual term for an emerging field in the intersection of health informatics, public health referring to health services on one hand and information delivered or enhanced through communication technologies and computer networks on the other hand [6]. In addition, the quality of health information on the internet became a subject of interest to healthcare professionals, information specialists, and different consumers of health care [7-14]. E-health attracts a growing interest that highlights an apparent need of an appropriate regulatory framework. A set of organizing principles, systems, standards, procedures, and policies which is needed to allow care givers, professionals, and healthcare organizations to concentrate on their efforts of delivering healthcare services [15-17].

The report of Institute of Medicine (IOM) indicated the necessity of information technology applications to improve both quality and safety in healthcare delivery. E-health has the potential to improve the access of care and access to educational opportunities for health professionals, and in remote areas it could reduce professional isolation and thus help in the recruitment as well as retention of health professionals[18, 19]. Furthermore, E-health should convey access to comprehensive health information instantly for patient care when and where needed, including both electronic medical records (EMR) and decision support knowledge based on the latest scientific findings and procedures [20]. Implementing home E-health systems and services are revealed as one of

the most important challenges to promote quality of life related to health in the information society and aging society [21-25].

In a political context of health expense reduction, enormous expectations for E-health services were evolved. The online accessible at the point of care will allow various clinical and health professionals to judge more effectively for the wellbeing of patients [26-27]. Moreover, the challenges for the 21st century were and will be to create meaningful, accurate E-health strategies, applications, and websites for communication interventions that successfully change behavior and improve health with a pivotal movement toward consumer education empowerment [28-30]. The growth of collaborative, and multi organizational medical research in recent years have extensive and remarkable innovations in E-health; on the other hand it presents new communication and quality challenges [31,32]. Increasing demands for large-scale comparative analysis of E-health studies has led to a similar demand for consistently of data that was speculated to be solved through developing standardized coding system [33, 34].

Although, E-health is exciting and shows potential, however, it presents new challenges, particularly in regard to acceptable and implementable standards, choice of technologies, overcoming traditional jurisdictional boundaries, initial investment as well as data ownership, privacy and confidentiality [35-40]. E-health performance measurement is playing an greater role in health care systems around the globe and in turn many countries are designing and implementing different aspects of measurement systems to achieve a range of objectives at organizational and national levels [41-48]; nevertheless, it is not applied on a large scale for E-health issues. Pay attention for performance initiatives is supposed to foster and reward improvement in health care delivery in general and help to address areas that require further attention in order to undertake a successful E-health scheme [49-54]. Additionally, auditing framework is an important element to assess performance, and improve quality of care [55]; where there is a strong argument that interventions delivered online and on distant should also be evaluated online to maximize the trial's external validity [56]. Therefore the objectives of the current study are to review the literature for the principle pil-

lars of E-health and to develop a criteria for KPIs that could be used in E-health assessment and to draw a framework that incorporate KPIs with the E- health pillars on quality dimension bases.

Methods

Data Collection

A computerized search was performed in the Google Scholar database from 1999 to 2009. The search was performed in English with the following keywords: E-health quality management, E-health delivery, reliability and challenges and in turn exploration for the main pillars of E-health that need assessment was carried out. The search was limited to E-health subject only. Nearly 130 manuscripts were reviewed, of which 85 are referenced in this paper. The study received approval from the Medical Informatics, College of Medicine, King Saud University.

Designing of KPIs and suggestion of dimensions of quality:

Developing of KPIs was carried out to fulfill the five criteria of SMART; i.e. specificity, measurability, achievability as well as to be realistic and monitoring progression of improvement along a definite time. Additionally, these KPIs were proposed to be inclusive allowing their customization to different health care sectors. Furthermore; through several discussions; a number of fundamentals were considered as dimensions of quality of different levels of performance that vary according to the target element to be evaluated.

Results

Reviewing of literatures revealed that there are variable organizational factors with key barriers to long-term success including lack of infrastructure to support electronic data capture, lack of prerequisite skills, not having defined policies and procedures, lack of a single clearinghouse for uniform data definitions and fragmented rather than integrated data systems with lack of training and support.

Analysis of the collected data led to the estimation of four pillars constituting the E-health including infrastructure, data & knowledge, standards & policy and people (figure.1).
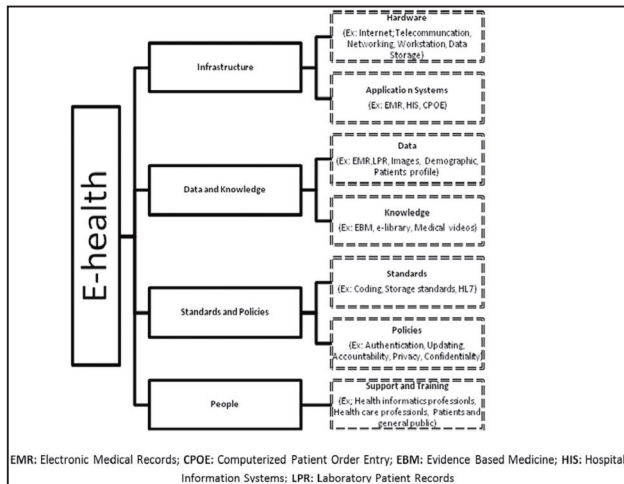
Figure 1. A diagram illustrating the E-health pillars with their components

Suggested Key Performance Indicators

a. Infrastructure

At present e-health is a broad classification with various activity related to the use of many e-technologies and infrastructure such as internet for facilitating healthcare practice. Infrastructure within the e-health is an organizational structure or framework which internally supported by different substructure in exchanging medical information. The internet (world wide web) one of the key component of infrastructure; is a powerful new communication available to people over the globe an unprecedented scale. It is believed that about 800 million publicly available page, out of its 3% are health related websites and further reported that 30 to 50% of users search for health related information [57,58]. The service of internet can be access through modems connected to the system with different tele communication capacity. For example Care Coordination/Home Telehealth (CCTH) was implemented by Veterans Health Administration (VHA) as home tele health program relating to the veterans suffering with chronic conditions in their homes. This E-health infrastructure coordinates through Health Information Technology (HIT) that supports clinical risk management, ongoing programme development, equipment contracting and analysis the outcomes. It operates through internet home telehealth programme which is one of the major component within the framework of infrastructure. In addition it enables fully protection and secure patient as well as organizational information

[20].The sub structure of the e-health comprises of different software's including workstations that allows for significant interactivity with the user and provides e health learning. Sometimes it is difficult for patients and professional to judge the quality of information. Therefore it is essential to ensure that the information provided is accurate and validated up-to-date. To avoid wrongful information and provide quality information different tools have implemented such as the American Medical Association and British Health Care Internet Association.

Information Communication Technology (ICT) infrastructure was proposed to initiate e-health communication such as phone lines, fiber trucks, cables, ISDN, DSL and high speed services used by various organization. Further infrastructure should include telecommunication, access to computer and various internet service providers. The drastic improvement of the internet and the extremely important of e-commerce, telecommunication is emerging as vital infrastructure for e-health access [44]. The service of the internet within the E-health showed advantageous such as access to medical information via the internet has the potential to speed the transformation of the patient physicians relationship and further allowed physicians to quickly access medical information in unprecedented scale.

b. Data & Knowledge

The Institute of Medicine (IOM) has emphasize the use of information technology in health care for major improvements in the quality of care. This information technology led to an increased interest in various applications such as electronic medical records (EMR), including computer-based physician, or provider, order entry (CPOE) and clinical decision support systems (CDSS) [59]. Electronic applications such as e-medicine, e-commerce, e-education, can be thought of as backed up by three support categories: (a) People, including practitioners, customers and participating organizations, (b) Public policy such as legal issues, standards and regulations and (c) Use and distribution including management and logistics. The infrastructure of these support groups can be divided into a general part, which deals with information distribution and the underlying network framework, and a second part, which deals with the knowledge infrastructure [60].

The knowledge repositories come in a great variety of shapes and packages, since the actual information is stored not only as traditional database records, but also as images, plain text, semi- structured or partially structured data. The source of this information can be as widespread as the web itself. More specifically, Internet based medical applications include electronic patient records, databases of clinical practice and literature, health portals, distance-learning type applications, decision-making tools for diagnosis and optimal treatment selection. Patients' Internet support groups and education packages revolutionize the traditional patient support, while terms such as tele-medicine and tele-consulting find their way into our everyday lives. All of the above applications rely on the fact that it is easier and cheaper to move data than people and/or other resources [60].

Information technologies (IT) such as patients electronic health records, e-prescribing, decision support systems, electronic management of chronic disease, and bar coding of drugs and biological products have been shown to reduce health care costs and medical errors. Study shows that two-thirds of the physicians surveyed cited the lack of a strategic plan for implementing applications and difficulty in recruiting experienced IT personnel as major barriers in e-health, while over one-half cited lack of sufficient knowledge of IT as a barrier to implementation of e-health. Also, lack of the ability to exchange clinical data with laboratories and hospitals is a major barrier for smaller physician practices [39].

Person can obtain information, and even health care itself, from a variety of places that are distant from each other and from the person. People seek health care information from numerous sources. Innovative computer technologies are needed to support the diversity of information that is sought. The technologies should be available in the places where information is sought, and they should support communication processes that a person may use to interact with the health care system to foster a healthy life. In line with what consumers want and need, information technology tools should provide a personalized information flow between patients and providers so that patients can take an active role in managing their own health care [61].

C. Standards and Policies

E-health is the use of information through the communication technologies for health among different health professionals. Therefore certain standards is necessary to facilitate transfer of clinical information among healthcare providers. Today health care has been shaped by each nations own interest. Standardization is the key to this. Once a nation decides to undertake e-health initiatives, different standardized policies must be developed to ensure the success of e-health. Based on these national policies and procedures, standard operation manual programs needs to be establish. It is believed policies and its procedures play a significant role in the adoption of e-health and the reduction of many structural impediments [62]. For example of patient safety, efficiency and ease of implementation, VHA (Veterian Health Adminstration) has national policies for the clinical, educational, technical and business elements of routine are delivered within its CCHT (Care Coordination/Home telehealth) Program [20]. There are also several norms and standards for medical information interoperability that are being developed:DICOM for medical images, SCP-ECG for ECG signals intercommunication, HL7 for medical messages exchange [50].

To understand the complexities of system, medical information such as electronic medical record should support clinical decision making, research and other regulatory processes. All the set information should be checked for authentication. In addition all the clinical documentation should be allowed to maintain as privacy and confidentiality. Since the electronic health record is interactive and therefore are many reviewers and users of documents. The information can be of various forms such as diagnoses, treatment and progress and laboratory analysis. These information that are shared as a result of a clinical relationship is considered confidential and must be protected. A study showed that many physicians benefits through the process of E-health, but also illustrated major barriers in implementation in their practices. These barriers include lack of access to capital by health care provider complex systems and lack of data standards that permit exchange of clinical data, privacy concerns and legal barriers [39]. The another barrier of e-health is the lack of security measures that required to assure both the

patients and organization that their relationship and transactions will be carried out in privacy, correctly, and timely. At the same time, many individuals are unfavorable to participate in e-health because they do not trust the e-health service providers' sites and their information [51]. Therefore appropriate standards and policies is one of the key pillar for an effective and successful E-health initiatives.

d. People

The present adults and teens are going online for health information through communication technology which become a daily part of life. Therefore information provided online play an important role in supporting the new partnership between providers, consumers/patients, and information technology [61]. Several factors contribute to a shift in the social role of patients from passive recipients to active consumers of health information [63]. The providers are coming to accept the situation that patients want to be involved "as a participant and partner in the flow of information" relating to their own health care [64].

Consumer health informatics is designed to empower consumers by putting health information into their hands, including information on their own health, such as diagnoses, lab results, personal risk factors, and prescribed drugs. The European Union's data protection directed all the current union members countries to enable the patients their medical records. To place medical records in the hands of patients so that can view own progress of health and for practical benefits [65]. Providers and patients are seeking new ways to enhance communication. E-mail is being used by patients and clinicians to communicate with each other. In addition, new special-purpose devices, such as in-home monitoring systems, and new uses of common devices, such as telephone data entry, are improving communication between patients and providers and thus improving health management [61]. It is therefore essential to build informatics tools that support the patient as a partner in health care and focus on the consumer, not the provider or institution. The patients, providers, and information systems needs with synergistic interrelationships to have valuable health information. In the process of creating such tools, consumers, providers, and informaticians must pay attention to ethical and social issues so that together they shape the future as they would like it to be, in terms of both how technology is used and what kinds of regulations are put in place [61].

Discussion

Based on reviewing of literatures, it was guesstimated that there are four main pillars of E-health to be assessed to ensure its quality. Integrating the quality dimensions with E-health pillars using the proposed criteria of KPIs resulted in a roadmap for assessment of E-health performance at all levels.

Regarding the infrastructure, it was reported in earlier researches that recent advances in biomedical engineering and continuous technological innovations in last two decades are promoting new challenges, especially in E-Health environments. In this context, the infrastructure availability, stability and interoperability are of high importance wherein these improvements require a standard-based design in order to achieve homogeneous solutions [26].

Furthermore, the spreading of wearable devices, oriented to the paradigm of patient environment and supported by wireless technologies as Bluetooth or ZigBee, is bringing new medical use cases based on Ambient Assisted Living, home monitoring of elderly, heart failure, chronic, under palliative care or patients who have undergone surgery, urgencies and emergencies, or even fitness auto-control and health follow-up. Several implementation experiences are based on ISO/IEEE11073 standard. These evolved E-Health services can improve the quality of the patient's care, increase the user's interaction, and assure that E-health applications to be more compatible with global telemedicine. clinical and health systems [27]. This supports the importance of having standards and policies in addition to supporting infrastructure and connectivity to be among main pillars of E-health [39].

Data and knowledge, should at least be a core standard for labeling health related information. Filters, applied manually or automatically, accept or reject whole sites of information based on preset criteria. These tools are based on the "gateway" approach to organizing access to the internet; resources are selected for their quality and relevance to a particular audience. The resources are reviewed and classified and the descriptions stored in a database.

These tools improve the recall and precision of internet searches for a particular group of consumers; for example students, researchers, academics, and practitioners in the health and medical sciences as well as patients seeking for medical information [2, 9]. This reflects the importance of data and knowledge as one of the principle pillars of E-health and to monitor it with KPIs.

Medical knowledge are changes so rapidly, healthcare providers need to keep their knowledge updated so that they can address patient specific needs. The availability of computers in many healthcare providers workplace environment enabled them to use the Internet in gaining knowledge [66]. The access to online database altered library use over the past decade, healthcare providers used to access the major database such as MEDLINE and PubMed to enhance the availability of clinical information in order to use evidence based in their treatment management plan. MEDLINE presented as the most common database to be accessed (40%), and the most well-known sites (69.6%) [67,68].

Online continuing education has an increase acceptance, healthcare providers specified that web-based CME is preferred more than the traditional face to face CME, that's lead many publishing, pharmaceutical and universities to initiated more online CME [69,70]. Providers who used the online CME show a satisfaction in the gaining experience Ruf D et al. shows in his research that online CME users present positive attitude by a present of 91.7% toward the online CME, while non-online CME users present 35.4%, which support the acceptance and importance of Internet in e-health [70,71]. Healthcare providers have the ability to suggest any extensive array of web-based learning opportunities, which lead to an excellent improvement in their knowledge, performance, and clinical effectiveness. Online CME provides many advantages for users, including convenience and flexible place, time, and schedule [70,71].

Healthcare providers require new information and knowledge to address question resulting from patients regarding their care, time is required to review the evidence-based literature for every clinical action. Novel methods to deliver required information into clinical workflow can improve this process, successful clinical decision support system already use to supply relevant clinical education on time. CDSS have the potential to assist healthcare providers decision-making, by delivering of evidence based suggestions for each individual patient [72].

Electronic forms of information with good communication can promote the appearance of patients as strategic partners in health care. Active use of e-mail, personal health records, and the Internet, especially integrated within an effective physician-patient relationship, holds the potential to improve health outcomes [73]. Giving patients access to their electronic medical record (EMR) can potentially improve medical care in a variety of area, particularly, by improving patient-provider relationship, as that technology allows them to communicate electronically to ask questions, schedule appointment, and to obtain follow-up test results [74,75].

Patients need to know about their treatment plan much more than what healthcare providers believe, especially if patient have special condition, We believe that the need to provide external source of information rather than hospital setting and appointment is important, physicians can help more by giving them external source of information like video program that can help them taking the right decision. Information needs to be available by email, text messaging, web and television which help in makes the development of specialized medical broadcast channels [76-78].

Internet can provide consumers the experience to access health information; there are an increasing number of web-based patient education sites that provide access to information, which is related to patients conditions E-health can be used to increase consumers knowledge about health topics and to support them understanding their personal disease management plan. Internet based education has the potential to balance and improve the established health care learning environment. Online communication support group expand the consumers to include other patients facing similar health challenges. Patients with disability also are able to benefit from technology to fundamentally participate in activates that would otherwise not be possible. Social integration and knowledge sharing that occurs through these new electronic community have the ability to increase the involvement in learning and expand the understanding of medical conditions [79-81].

Concerning the suggested third pillar; standards and policies; it was indicated that challenges to the development of appropriate yet adaptable policies and standards are proving to be of significant importance for the success of e-health projects [17]. Strategies applied included 'quality assurance' marking, specially designed search engines, and operational criteria for individuals to apply to sites as well as the medical community's roles and responsibilities in relation to this burgeoning area [5]. Furthermore, various legislations have been enacted at all levels of E-health that aimed in part to improving confidence in the privacy and confidentiality of personal health information [40]. The American Medical Association has developed principles to guide development and posting of web site content, govern acquisition and posting of online advertising and sponsorship, ensure site visitors' and patients' rights to privacy and confidentiality, and provide effective and secure means of e-commerce [18].

Finally, the last pillar is people which includes all both providers and beneficiary of E-health. It was demonstrated that E-health is having profound impacts on health and health care. It has the potential to improve the effective and efficient delivery of healthcare, empower and educate consumers, support decision-making, enable interaction between consumers and professionals, support the training and revalidation of professionals, and reduce inequalities in health [3].

Consumers, which include patient and healthy people, are using information and communication technology to obtain health information. Informaticians and health care IT professional should play an important role in design, implement and support the new partnership between health providers, consumers, and information technology [82]. Several factors contribute to a shift in the social role of patients from passive recipients to active consumers of health information providers are coming to accept the situation that patients want to be involved in their own health management [63,83]. Consumer health informatics is designed to empower consumers by putting health information into their hands, including information on their own health, such as diagnoses, lab results, personal risk factors, and prescribed drugs. The European Union's data protection directive (in effect since October 1998) requires all member countries to enact legislation enabling patients to have access to their medical records [65].

E-health provide physician with the best way to improve their practice experience, which include the use of e-learning, that shows improvement in clinical decision making for healthcare providers through online group casework [84]. Also, online CME can improve providers knowledge, skills, and practice decisions, with outcomes, they are more likely to suggest evidence-based clinical choice in their practice [85].

Conclusions

E-health comprises four chief pillars that should be evaluated to ensure the quality of performance. Furthermore, auditing and evaluation are important part in performance assessment facilitating providing and sharing data between units. Key performance indicators can be driven from these five pillars to facilitate for systematic evaluation.

Recommendations

Developing global and/or national-wide, accredited, standardized, evidence-based KPIs; with definite coding system; could be an endeavor to monitor the incremental improvement of E-health. It is necessary that KPIs be not only reliable, valid, easy to implement, demonstrably relevant to patient care outcomes but also as comprehensive as possible to gain a wide acceptance. Furthermore, a survey of health care providers for E-health elements should follow to validate the suggested KPIs.

Acknowledgment

References

1. Eysenbach G, Köhler C. How do consumers search for and appraise health information on the World Wide Web? Qualitative study using focus groups, usability tests, and in-depth interviews. BMJ, March, 2002; 324(9): 574.

2. Eysenbach G, Diepgen TL. Towards quality management of medical information on the internet: evaluation, labeling, and filtering of information. BMJ, Nov, 1998; 317(28).

3. Powell JA, Darvell M, Gray JA. The doctor, the patient and the world-wide web: how the internet is changing healthcare. J R Soc Med, Feb, 2003; 96: 74–76.

4. Ritterband LM, Borowitz S, Cox DJ, Kovatchev B, Walker LS, et al. Using the Internet to Provide Information Prescriptions. Pediatrics, 2005; 116: 643-47.

5. Theodosiou L, Green J. Emerging challenges in using health information from the internet. Adv. Psychiatr. Treat. 2003; 9: 387-396.

6. Kwankam S. What e-Health can offer? Bulletin of the World Health Organization, Oct; 2004; 82 (10).

7. Gagliardi A, Jadad AR. Examination of instruments used to rate quality of health information on the internet: chronicle of a voyage with an unclear destination. BMJ, March; 2002; 324(9): 569- 573.

8. Kim P, Eng TR, Deering MJ, Maxfield A. Published criteria for evaluating health related web sites: review. BMJ, March, 1999; 318(6).

9. Wilson P. How to find the good and avoid the bad or ugly: a short guide to tools for rating quality of health information on the internet. BMJ, March, 2002; 324(9): 598-601.

10. Terry N. Regulating health information: a US perspective. BMJ, March, 2002; 324(9): 602.

11. Croft DR, Peterson MW. An evaluation of the quality and contents of asthma education on the World Wide Web. CHEST, 2002; 121: 1301–1307.

12. Ostry A, Young ML, Hughes M. The quality of nutritional information available on popular websites: a content analysis. Health Education Research, 2008; 23(4): 648–655.

13. Eysenbach G, Powell J, Kuss O, Eun-Ryoung S. Empirical studies assessing the quality of health information for consumers on the World Wide Web: A systematic review. JAMA, 2002; 287: 2691-700.

14. Gray JA. Hallmarks for quality of information. BMJ, Nov, 1998; 317(28).

15. Callens S, Cierkens K. Legal aspects of E-health. Stud Health Technol Inform. 2008; 141: 47-56.

16. Lupiáñez-Villanueva F, Mayer MA, Torrent J. Opportunities and challenges of Web 2.0 within the health care systems: an empirical exploration. Inform Health Soc Care. Sep, 2009; 34(3): 117-26.

17. Scott RE, Jennett P, Yeo M. Access and authorization in a global e-health policy context. International Journal of Medical Informatics, 2004; 73: 259-266.

18. Winker MA, Flanagin A, Chi-Lum B, White J, Andrews K, et al. Guidelines for medical and health information sites on the internet: Principles governing AMA web sites. JAMA, March, 2000; 283(12): 1600-6.

19. Carnall D. American Medical Association moves to regulate prescribing on the internet. BMJ , July, 1999; 319 (24).

20. Darkins A, Ryan P, Kobb R, Foster L, Edmonson E, et al. Care coordination/home telehealth: The systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. Telemedicine and E-health, Dec, 2008; 14 (10): 1118- 27.

21. Mannion R, Goddard M. Performance measurement and improvement in health care. Appl Health Econ Health Policy, 2002; 1(1): 13-23.

22. O'Kane ME. Performance-based measures: the early results are in. J Manag Care Pharm. Mar, 2007; 13: 3-6.

23. Berler A, Pavlopoulos S, Koutsouris D. Using key performance indicators as knowledge-management tools at a regional health-care authority level. IEEE Tran INF Technol Biomed, Jun, 2005; 9(2): 184-92.

24. Raftery J, Roderick P, Stevens A. Potential use of routine databases in health technology assessment. Health Technol Assess, May, 2005; 9(20): 1-92.

25. Kirchner MJ, Funes VA, Adzet CB, Clar MV, Escuer MI, et al. Quality indicators and specifications for key processes in clinical laboratories: a preliminary experience. Clin Chem Lab Med, 2007; 45(5): 672-7.

26. Roig F, Saigí F. Difficulties of incorporating telemedicine in health organizations: analytical perspectives. Gac Sanit. Mar-Apr. 2009; 23(2): 147.

27. Jenkins M, Levy J, Cohen E, Yoon S, Singer J, Mostashari F. Integration of self-management tools in personal and provider e-health records. Stud Health Technol Inform. 2009; 146: 179-84.

28. Schwamm L, Reeves MJ, Frankel M. Designing a sustainable national registry for stroke quality improvement. Am J Prev Med, Dec, 2006; 31(2): 251-7.

29. Chew DP, Allan RM, Aroney CN, Sheerin NJ. National data elements for the clinical management of acute coronary syndromes. Med J Aust, May, 2005; 2(182): 1-14.

30. Watters DA, Green AJ, van Rij A. Guidelines for surgical audit in Australia and New Zealand. ANZ J Surg, Jan-Feb, 2006; 76(1-2): 78-83.

31. Mühlig S, Rinne H, Mehren F, Petermann F, Butt U, Worth H. In-patient asthma education and self-management training in clinical practice--a national survey in Germany. Pneumologie, Mar, 2002; 56(3): 167-75.

32. Simpson MR. Engagement at work: a review of the literature. Int J Nurs Stud, Jul, 2009; 46(7): 1012-24.

33. Langabeer JR 2nd, Walji MF, Taylor D, Valenza JA. Economic outcomes of a dental electronic patient record. J Dent Educ, Oct, 2008; 72(10): 1189-200.

34. Marziali E. E-health program for patients with chronic disease. Telemed JE Health, Mar, 2009; 15(2): 176-81.

35. Vitacca M, Mazzù M, Scalvini S. Socio-technical and organizational challenges to wider e-Health implementation. Chron Respir Dis, 2009; 6(2): 91-7.

36. Pau I, Seoane F, Lindecrantz K, Valero MA, Carracedo J. Home e-health system integration in the Smart Home through a common media server. Conf Proc IEEE Eng Med Biol Soc, 2009; 6171-4.

37. Seibert PS, Whitmore TA, Patterson C, Parker PD, Otto C, et al. Telemedicine facilitates CHF home health care for those with systolic dysfunction. Int J Telemed Appl, 2008; 235031.

38. James B. Information system concepts for quality measurement. Med Care, Jan, 2003; 41: 171-9.

39. Anderson JG. Social, ethical and legal barriers to E-health. International Journal of Medical Informatics, 2007; 76: 480–3.

40. Alvarez RC. The promise of e-Health-a Canadian perspective. EHealth International, 2002; 1: 41-6.

41. Thomson R, Taber S, Lally J, Kazandjian V. UK Quality Indicator Project (UK QIP) and the UK independent health care sector: a new development. Int J Qual Health Care, Apr, 2004; 16(1): 51-6.

42. Rawabdeh AA. An e-health trend plan for the Jordanian health care system: a review. Int J Health Care Qual Assur, 2007; 20(6): 516-31.

43. Zinn J, Getzen T. Developing key laboratory performance indicators: a feasibility study: Potential roles for CLMA. Clin Lab Manage Rev, May-Jun, 1995; 9(3): 178-98.

44. Wickramasinghe NS, Fadlalla AM, Geisler E, Schaffer JL. A framework for assessing e-health preparedness. Int J Electron Healthc. 2005; 1(3): 316-34.

45. Zinn J, Zalokowski A, Hunter L. Identifying indicators of laboratory management performance: a multiple constituency approach. Health Care Manage Rev, winter, 2001; 26(1): 40-53.

46. Donaldson NE, Rutledge DN, Ashley J. Outcomes of adoption: measuring evidence uptake by individuals and organizations. Worldviews Evid Based Nurs. 2004; 1(1): 41-51.

47. Norman CD, McIntosh S, Selby P, Eysenbach G. Web-assisted tobacco interventions: empowering change in the global fight for the public's (e) Health. J Med Internet Res. 25; Nov, 2008; 10(5): 48.

48. Lorence DP, Churchill R. Communicating e-health research across organisational boundaries: a medical model for temporary or limited communities of practice. Int J Electron Healthc. 2008; 4(3-4): 257-66.

49. Skorning M, Bergrath S, Rörtgen D, Brokmann JC, Beckers SK, et al. [E-health in emergency medicine-the research project Med-on-@ix] Anaesthesist. Mar, 2009; 58(3): 285-92.

50. Martinez I, Escayola J, Martinez-Espronceda M, Serrano L, Trigo JD, et al. Implementation experiences of ISO/IEEE11073 standard applied to new use cases for e-health environments. Conf Proc IEEE Eng Med Biol Soc. 2009; 1679-82.

51. Katsikas S, Lopez J, Pernul G. The challenge for security and privacy services in distributed health settings. Stud Health Technol Inform. 2008; 134: 113-25.

52. Sharma SK, Xu H, Wickramasinghe N, Ahmed N. Electronic healthcare: issues and challenges. Int J Electron Healthc. 2006; 2(1): 50-65.

53. Dugbatey K. National health policies: sub-Saharan African case studies (1980-1990). Soc Sci Med. Jul,1999; 49(2): 223-39.

54. Yank G. Quality improvement in health care organizations: a general systems perspective. Behav Sci. Apr, 1995; 40(2): 85-103.

55. Donaldson NE, Rutledge DN, Ashley J. Outcomes of adoption: measuring evidence uptake by individuals and organizations. Worldviews Evid Based Nurs, 2004; 41-51.

56. Lu JF, Hsiao WC. Does universal health insurance make health care unaffordable? Lessons from Taiwan. Health Aff (Millwood), May-Jun, 2003; 22(3): 77-88.

57. Lawrence S, Giles CL. Accessibility of information on the Web. Nature 1999; 400: 107–109.

58. Peterson MW. Are medical Websites a boon or bane for patients and physicians? Med Behav 1999; 33–34.

59. Berner ES, Detmer DE, Simborg D. Will the Wave Finally Break? A Brief View of the Adoption of Electronic Medical Records in the United States. Journal of the American Medical Informatics Association 2005; 12(1).

60. Dotsika F. From data to knowledge in e-health applications: an integrated system for medical information modelling and retrieval. Medical Informatics 2003; 28(4): 231-251.

61. Kaplan B, Brennan PF. Consumer Informatics Supporting Patients as Co-Producers of Quality. Journal of the American Medical Informatics Association 2001; 8(4): 309-316.

62. Samiee S. The internet and international marketing: is there a fit? Journal of Interactive Marketing 1998; 12(4): 5–20.

63. Anderson JG. Consumers of e-health: Patterns of use and barriers. Social Science Computer Review 2004; 22(2).

64. Wilson EV, Lankton NK. Modeling Patients' Acceptance of Provider-delivered E-health. Journal of the American Medical Informatics Association 2004; 11(4): 241-248.

65. Eysenbach G. Consumer health informatics. BMJ 2000; 320: 1713-1716.

66. Haynes RB, McKibbon KA, Walker CJ, Ryan C, Fitzgerald D, Ramsden ME. Online access to MEDLINE in clinical settings: a study of use and usefulness. Ann Intern Med. 1990; 112: 78-84.

67. De Groote SL, Dorsch JL. Measuring use patterns of online journals and databases. Journal of the Medical Library Association 2003; 91: 231-240.

68. Cullen RJ. In search of evidence: family practitioners' use of the Internet for clinical information. J Med Library Assoc 2000; 90(4): 370-379.

69. Harden RM. A new vision for distance learning and continuing medical education. Journal of Continuing Education in the Health Professions 2005; 25: 43-51.

70. Ruf D, Kriston L, Berner M, Härter M. General practitioners and online continuing medical education – which factors influence its use?, Ger Med Sci. 2009; 7(8).

71. Schoen MJ, Tipton EF, Houston TK, Funkhouser E, Levine DA, et al. Characteristics that predict physician participation in a Web-based CME activity: the MI-Plus study. J Contin Educ Health Prof. Fall 2009; 29(4): 246-53.

72. Rosenbloom S, Geissbuhler A, Dupont W. et al. Effect of CPOE user interface design on user-initiated access to educational and patient information during clinical care. J Am Med Inform Assoc 2005; 12(4): 458–73.

73. Winkelman WJ, Leonard KJ, Rossos PG. Patient-perceived usefulness of online electronic medical records: employing grounded theory in the development of information and communication technologies for use by patients living with chronic illness. JAMIA 2005; 12(3): 306-14.

74. Ross SE, Lin CT. The effects of promoting patient access to medical records: a review. J Am Med Inform Assoc. 2003; 10: 129–38.

75. Hassol A, Walker JM, Kidder D. et al. Patient experiences and attitudes about access to a patient electronic health care record and linked web messaging. J Am Med Inform Assoc. 2004; 11(6): 505–13.

76. Dickinson D, Raynor DKT, Kennedy JG, Bonaccorso S, Sturchio J. What information do patients need about medicines? BMJ 2003; 327: 861-4.

77. Kennedy JG. "Doc, tell me what I need to know"— a doctor's perspective. BMJ, 2003; 327.

78. Deyo RA, Cherkin DC, Weinstein J, Howe J, Ciol M, Mulley AG Jr. Involving patients in clinical decisions: impact of an interactive video program on use of back surgery. Med Care. Sep, 2000; 38(9): 959-69.

79. Demiris G, Afrin LB, Speedie S, Courtney KL, Sondhi M, et al. Patient-centered applications: use

of information technology to promote disease management and wellness. A white paper by the AMIA knowledge in motion working group. J Am Med Inform Assoc. Jan-Feb, 2008; 15(1): 8-13.

80. Wilson EV, Lankton NK. "Modeling Patients' Acceptance of Provider-Delivered EHealth". Journal of the American Medical Informatics Association 2004; (11): 241-248.

81. Lewis D. Computer-based approaches to patient education: a review of the literature. J Am Med Inform Assoc. Jul, 1999; 6(4): 272–82.

82. Kaplan B, Flatley Brennan P. Consumer Informatics Supporting Patients as Co-Producers of Quality. J Am Med Inform Assoc. Jul-Aug 2001; 8(4): 309–316.

83. Vance Wilson E, Lankton KN. Modeling Patients' Acceptance of Provider-delivered E-health. J Am Med Inform Assoc. Jul-Aug 2004; 11(4): 241–248.

84. Gresty K, Skirton H, Evenden A. Addressing the issue of e-learning and online genetics for health professionals. Nursing & Health Sciences, 2007; 9(1): 14–22.

85. Casebeer L, Brown J, Roepke N, Grimes C, Henson B, et al. Evidence-based choices of physicians: a comparative analysis of physicians participating in Internet CME and non-participants. BMC Medical Education 2010; 10: 42.

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