Role of Information Technology in Evidence Based Medicine: Advantages and Limitations

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Abstract

The significant impact of preventable medical errors on patient safety and the "chasm" separating the quality level of current United States healthcare from what the quality level should be are critical public concerns. Using information technology to provide evidence-based medicine (EBM) has been proposed as one of the important initiatives to significantly improve the current situation. The practice of EBM requires access to clinical evidence and a change in the way medical decisions are made. Internet access, mobile devices and clinical decision-support tools are available to assist practitioners with this process. With increasing demands for health care organizations to manage patients according to established clinical evidence and practice guidelines, health care administrators should incorporate at least some aspects of EBM, including the associated expenses, into their IT strategic planning process.

INTRODUCTION

Information technology (IT) plays a crucial role in the practice of evidence-based medicine (EBM) by allowing health care practitioners to access and evaluate clinical evidence as they formulate their patient care strategies. This oftentimes involves an analysis of a large amount of complex information. Hence, health care administrators responsible for implementing information systems and EBM policies and guidelines will need to be familiar with EBM concepts, as well as the capabilities and limitations of available IT solutions employed to perform EBM.

PURPOSE

The purpose of this paper is to introduce basic EBM concepts important to health care administrators, and then to analyze the advantages and limitations of information technologies utilized by health care practitioners to perform EBM. These technologies include clinical information systems, clinical decision-support systems, wireless technology, and hand-held devices.

PROBLEM

In 1999, a highly publicized Institute of Medicine (IOM) report, To Err is Human: Building a Safer Health System, exposed the significant impact of preventable medical errors on patient safety in the United States. Another IOM report, Crossing the Quality Chasm: A New Health System for the 21 st Century, followed in 2001. This report highlighted the significant gap between the health care we could have and the health care that is currently available in the United States. The IOM proposed several initiatives to prevent medical errors and improve the quality of health care in the United States. Using information technology and providing medical care based on the best available evidence are among these proposals. These two proposals are also incorporated into President George Bush's order to implement a nationwide interoperable health information technology infrastructure and establish the National Health Information Technology Coordinator (Executive Order No. 13335, 2004).

BACKGROUND

According to Straus, Richardson, Glasziou, and Haynes (2005), the term evidence-based medicine was introduced by a group from McMaster University in 1992. Although EBM may not have been immediately accepted by the medical community, it is now gaining in popularity. For example, as of October, 2006, a search in the Pubmed database using the keywords, evidence-based medicine, yielded 22,965 citations. EBM “requires the integration of the best research evidence with [health care providers'] clinical expertise and [each] patient's unique values and circumstances” (Straus et al., 2005, p. 1). Based on this description, the benefits of EBM seem intuitive. However, some critics of EBM suggest

that it is an academic concept that promotes a cookbook approach at the expense of individual patient values, or that it is simply a manager's cost-cutting tool (Straus et al., 2005, p. 8). Nevertheless, based on the IOM reports and prevalence of publications, the proponents seem to be overcoming the critics of EBM. It is at least safe to say that EBM will continue to be a major initiative.

The federal government, managed care organizations and even some of the nation's largest employers are pressing for EBM, particularly through the development and use of clinical guidelines to improve quality and reduce costs (Butcher, 2006). According to Kaiser Permanente's Care Management Institute, (n.d.) Kaiser Permanente is investing significantly in guidelines and a computer-based clinical information system to deliver evidence-based information at the point of care.

The practice of EBM requires access to evidence and a change in the way medical decisions are made. Health care practitioners, who have in the past primarily relied on their individual experience, medical textbooks and expert opinion, will be expected to integrate the results of recent, valid and relevant research into their individual patient decisions. Several sources of clinical evidence are available, and using information technology significantly facilitates the search process. Access to current clinical evidence ranges from journal subscriptions (paper or electronic), to electronic information systems that include collections of books, journals and databases. Systematic reviews, such as those from the Cochrane Collaboration, are also available. Specialized or general evidence-based databases, such as Ovid's Evidence Based Medicine Reviews can also be searched to obtain abstracts of articles that have been appraised for merit and relevance (Straus et al., 2005, p. 39). For the future, however, EBM proponents envision clinical decision-support systems, which can be accessed from almost any setting, that link relevant information from a patient's electronic medical record to the most up-to-date evidence. (Goldschmidt, 2005, p. 71; Mendelson & Carino, 2005, p. 134; Straus et al., 2005, p. 34). Most health care practitioners today obtain access to information systems and decision support systems via desktop computers. Wireless handheld computers have also been proposed for increased convenience and efficiency (Shannon, Feied, Smith, Handler, & Gillam, 2005, p. 310). Even though these tools provide for increased mobility, they are also associated with significant privacy concerns.

OBJECTIVES

One objective of this paper is to explore basic EBM concepts and to perform an analysis of the role of EBM in medical practice by contrasting the benefits of EBM with key concerns surrounding its implementation. Furthermore, this paper aims to analyze the roles, advantages and limitations of currently available and proposed IT solutions utilized to perform EBM. Finally, these analyses will be used to develop recommendations that can be used by health care administrators to strategically plan for EBM implementation.

LITERATURE REVIEW

Practicing EBM involves using the best clinical evidence, obtained using a rigorous methodology, to make decisions for an individual patient or population (Bartkowiak, 2004, p. 254; Eddy, 2005, p. 16; Hurwitz, Tornetta, & Wright, 2006, p, 1873; Mendelson & Carino, 2005, p. 133; Straus et al., 2005, p. 1). The rigorous EBM methodology entails the use of a "problem solving algorithm [involving] (1) formulating answerable questions, (2) gathering evidence, (3) evaluating the evidence, (4) putting evidence into practice, and (5) evaluating the results of putting evidence into practice" (Hurwitz, et al., 2006, p. 1873). Evaluating evidence and putting evidence to practice requires clinicians to understand and apply "statistics, probability, clinical research, guided inquiry, systematic reviews, and levels of evidence" (Hurwitz, et al., 2006, p. 1873). Bartkowiak (2004, 2005a, & 2005b), Hurwitz, et al. (2006), and Straus, et al. (2005) provide instruction on how to use these tools to apply the EBM methodology. They each describe how health information technology can facilitate this process, particularly with regard to formulating the question, gathering evidence, and evaluating evidence for validity and relevance.

Web sites (Table 1) are also available, such as those from the Health Services Library of the University of Carolina ("The Well-Built Clinical Question") and the University of Manchester ("Evidence 4U"), to assist practitioners with formulating well-constructed questions (Bartkowiak, 2004). Other web sites contain specific databases and search engines, some free of charge (PubMed/MEDLINE with the Clinical Queries feature) and others requiring a fee (Cochrane Library, Bandolier, Ovid's Evidence Based Medicine Reviews, Clinical Evidence and TRIP Database Plus), that can be accessed by practitioners to review clinical study outcomes and systematic reviews (Bartkowiak, 2005a; Straus, et. al, 2005).

Figure 1

Table 1: Useful Evidence-Based Medicine URLs

Ovid – Evidence Based Medicine Reviews	http://www.ovid.com
University of Carolina – "The Well-Built Clinical Question"	http://www.hsl.unc.edu/Services/Tutorials/EBM/Question.htm
University of Manchester – "Evidence 4U"	http://www.evidence4u.man.ac.uk/modules.php?modname=custompage&name=ebm_home
PubMed/MEDLINE	http://www.ncbi.nlm.nih.gov/entrez/query.fcgi
Cochrane Library	http://www.thecochranelibrary.com
Bandolier	http://www.jr2.ox.ac.uk/bandolier/index.html
Clinical Evidence	http://www.clinicalevidence.com/ceweb/conditions/index.jsp
TRIP Database Plus	http://www.tripdatabase.com
Critical Appraisal Skills Programme (CASP)	http://www.phru.nhs.uk/casp/casp.htm
Centre for Evidence-Based Medicine	http://www.cebm.net/critical_appraisal.asp

Bartkowiak (2005b) cogently distills the critical evaluation of evidence into three questions: "1) is it valid?; 2) what are the results?; and 3) is it applicable to the patient?" (p. 113). Several web sites are available to assist with this evaluation (Bartkowiak, 2005b; Hurwitz, et al., 2006; and Straus, et al., 2005). For example, the Critical Appraisal Skills Programme (CASP) section of the United Kingdom's National Health Service web site provides several resources, including forms that can be used to critically appraise evidence (Bartkowiak, 2005b, p. 113). Worksheets can also be accessed at The Centre for Evidence-Based Medicine web site, as well as a step-by-step approach to evidence appraisal (Bartkowiak, 2005b, p. 114). Evidence-based practice guidelines have also been developed by several organizations and working groups. These guidelines provide a review of the literature and rate the overall quality of evidence based on a grading scale (Hurwitz, et al., 2006, p. 1878). Hurwitz, et al. (2006) and Straus, et al. (2005) provide several web sites, such as those for the Cochrane Collaboration, Ovid's Evidence Based Medicine Reviews and the British Medical Journal's "Clinical Evidence," where various guidelines can be accessed.

Several groups are evaluating computer-based clinical decision-support systems for practicing EBM. It is envisioned that these tools will generate patient-specific recommendations based on a comparison of the individual patient characteristics to a computerized knowledge base (Garg, et al., 2005, p. 1223). Apkon, et al. (2005) performed a patient-level randomized trial of the use of Problem-Knowledge Couplers, a decision support tool proposed for the Department of Defense health information network, on quality of care. According to Apkon, et al. (2006), the trial did not provide strong evidence to support the utility of the tool, but it did "demonstrate the value of rigorous evaluation of decision support information technology" (p. 2388). Additionally, Garg, et al. (2005) performed a systematic review of 100 controlled trials of the use of clinical decision support systems, published from 1998 through September 2004, and concluded that "the majority of available systems are not yet ready for mainstream use" (p. 1236).

Health care practitioners require access to the Internet to efficiently retrieve evidence-based information. Many health care practitioners are looking to mobile handheld devices to provide more real-time access at the patient's bedside (Cocosila & Archer, 2006; Krauskipt, 2006; Shannon, Feied, Smith, Handler & Gillam, 2005; Lu, Xiao, Sears, & Jacko, 2005). These include wireless devices and devices that are equipped to be synchronized through wired connectivity in a stationary environment. According to Lu, Xiao, Sears, and Jacko (2005), 40 percent of physicians in the United States owned a personal digital assistant (PDA) in 2003. Cocosila and Archer (2006) have identified many of the important issues associated with mobile device implementation in the health care environment, including interference with telemetry equipment, security and privacy, compatibility and integration, acceptance, and ease of use.

ANALYSIS

Physicians and other health care practitioners have historically relied on their extensive medical training, individual experience and expert opinion to make decisions concerning the medical management of their patients. Very little evidence-based clinical information was available, and much of the evidence that was available was based on limited or poorly conducted clinical investigations (Eddy, 2005, p. 10; Mendelson & Carino, 2005, p. 134). However, this began to change in the 1980s and 1990s as the variability in medical practice and significant occurrence of preventable medical errors became public knowledge. Incorporating information based on valid and relevant clinical evidence does appear to be a valid approach to improving the medical decision-making process and ultimately, clinical outcomes.

Generating robust clinical evidence and incorporating the rigor of EBM into mainstream medical practice will require significant cost and a shift in the way medical decisions are made. Health care practitioners performing EBM must be skilled at formulating proper questions and critically evaluating the available evidence based, for many, on unfamiliar statistical concepts. Recognizing this, EBM

methods are being incorporated into medical education programs (Straus, 2005). Regulatory agencies are also requiring medical product companies to produce more evidence based on properly conducted randomized controlled trials (Mendelson & Carino, 2005, p. 134). Even so, as aptly stated by Hurwitz, et al. (2006), practicing evidence-based medicine requires health care practitioners to "adopt better evidence by changing their opinions and more importantly, their practice, when confronted with good evidence. This step may be the most difficult... " (p. 1878). Furthermore, it is also notable that there is little evidence to support the benefit of EBM (Mendelson & Carino, 2005, p. 133). Nevertheless, the significant cost of medical errors and growing public demand for quality health care will likely increase the requirement for and acceptance of EBM.

Based on the literature, current computer-based clinical decision-support systems are limited in application. According to Short, Frischer, and Bashford (2004), the adoption of current systems has been hindered due to several factors, including physicians' limited skills and confidence in the system recommendations; limited understanding of the statistical concepts, such as risk reduction; and time pressures. Still, many physicians have a positive outlook on the potential for these systems, particularly relating to practitioner performance (Apkon, et al., 2005, p. 2393; Garg, et al., 2005, p. 1229; Short, et al., 2004, p. 359). The randomized trial conducted by Apkon, et al. (2005) demonstrates the value of rigorously evaluating these tools. Hence, future improved decision-support systems should be similarly scrutinized prior to broad adoption.

Internet access is required to incorporate EBM into the medical environment. Bringing EBM to the bedside using wireless devices, however, is more complex. Although it seems reasonable that practicing EBM at the bedside using mobile devices would increase efficiency, several barriers to bedside implementation have been identified. These include privacy and security concerns, time constraints, negative patient perceptions, and ease of use challenges.

Serious concerns exist surrounding the security and privacy of wireless communications in health care organizations. Cocosila and Archer (2006) quote Albright when stating, "healthcare executives point out that their privacy and security concerns are comparable to those in the financial services industry. Even so, the heathcare industry lags behind in dealing with sensitive data" (p. 241). Cocosila and Archer (2006) explain that the goal for wireless communications is to provide "wired equivalent security" (p. 241). This goal has not yet been realized, as even those institutions at the forefront of wireless adoption do not allow wireless access to patient data (Cocosila & Archer, 2006, p. 241; Krauskopf, 2006, p. 49).

Lack of time to reference clinical evidence in the busy practice setting in addition to concerns regarding negative patient perceptions are also notable (Cocosila & Archer, 2006; Short, Frischer & Bashford, 2004). However, Lu, et al. (2005) suggest, based on their review of the literature, that using PDAs actually "saves clinicians time in regard to accessing, retrieving, and recording data... allowing them to do more direct patient care" (p. 414). Lu, et al.'s (2006) research also suggests that the physicians are more concerned than patients about negative patient perceptions of PDA use (23% of physicians were concerned versus 10% of patients).

Radio frequency interference of wireless devices with telemetry monitoring equipment is another important concern (Cocosila & Archer, 2006, p. 240). This concern can be alleviated by restricting wireless technology to Wireless Local Area Networks (WLAN). Additionally, most medical telemetry monitoring devices are migrating to a reserved communications band, the Wireless Monitoring Telemetry Service (WMTS) band at 608-614 MHz (Cocosila & Archer, 2006, p. 240).

The screen size, keypad size and screen resolution of many mobile devices cause these devices to be more difficult to use. Screen size and resolution, in particular, limit the ability of health care practitioners to read full evidence-based medicine articles and clearly see graphics and pictures (Cocosila & Archer, 2006, p. 243). Hence, practitioners using smaller mobile devices will have to depend on summaries developed specifically for these devices.

RECOMMENDATIONS FOR HEALTH CARE ADMINISTRATORS

Given the current health care climate with increasing demands for health care organizations to manage patients according to established clinical evidence and practice guidelines, health care administrators should incorporate at least some aspects of EBM, including the associated expenses, into their IT strategic plans. If possible, administrators should provide Internet access to health care providers, although this will not always be possible in some rural locations. As with any IT system, the requirements, comfort level and experience level of potential IT users should be assessed prior to designing or implementing an

EBM system. Available EBM systems include free-access to electronic database and search engines to subscriptions to specialized EBM services or clinical decision-support systems. In general, the literature does not support the broad implementation of currently-available clinical decision-support systems. However, if the health care organization prides itself in being at the forefront of technology adoption, health care administrators should consider planning to evaluate clinical decision-support systems for future implementation. Similarly, it does not appear that wireless and other mobile devices should be implemented for bedside EBM practice alone. However, EBM capabilities should be considered as a part of any broader mobile device implementation initiative. Currently, privacy and security issues are the most significant limitations to broad wireless mobile device implementation.

CONCLUSION

Incorporating valid and relevant clinical evidence into medical management decisions will continue to be emphasized as efforts are made to reduce medical care errors and variability. Since IT plays a crucial role in EBM implementation, health care administrators will need to be familiar with EBM concepts and incorporate these into their strategic IT plans. Several web sites and recent literature are available to describe and assist with performing EBM. Those practicing EBM will need to be able to assess the relevance and validity of available evidence, which may require new skills. Health care IT will continue to be an essential component of EBM. Future IT will likely include mobile devices and clinical decision-support tools.

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GLOSSARY

Clinical Decision Support System (CDSS): Any system designed to improve clinical decision making related to diagnostic or therapeutic processes of care. (Agency for Healthcare Research and Quality Patient Safety Network, http://psnet.ahrq.gov/glossary.aspx)

Evidence-based medicine (EBM): the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. (Centre for Evidence-Based Medicine, http://www.cebm.net/glossary.asp)

Information Technology (IT): Processing information by computer. IT is an umbrella term for the entire computer industry and its latest moniker, which took hold in the 1990s. It actually took 40 years before the industry settled on what to call itself. First it was “electronic data processing” (EDP), which was followed by “management information systems” (MIS) and then “information systems” (IS). (TechWeb Technoencyclopedia, http://www.techweb.com/encyclopedia/)

Personal Digital Assistant (PDA): A handheld computer for managing contacts, appointments and tasks. It typically includes a name and address database, calendar, to-do list and note taker, which are the functions in a personal information manager. Wireless PDAs may also offer e-mail, Web browsing and cellular phone service. Data are synchronized between the PDA and desktop computer via a cabled connection or wireless. (TechWeb Technoencyclopedia, http://www.techweb.com/encyclopedia/)

References

r-0. Apkon, M., Mattera, J.A., Lin, Z. Herrin, J, Bradley, E.H., Carbone, M. Holmboe, E.S., Gross, C.P., Selter, J.Gl, Rich, A.S., & Kurmholz, H.M. (2005). A randomized outpatient trial of a decision-support information technology tool. Archives of Internal Medicine 165, 2388-2394.
r-1. Bartkowiak, B.A. (2004). Searching for evidence-based medicine in the literature. Part 1: The start. Clinical Medicine & Research, 2(4), 254-255.
r-2. Bartkowiak, B.A. (2005a). Searching for evidence-based medicine in the literature. Part 2: Resources. Clinical Medicine & Research, 3(1), 39-40.
r-3. Bartkowiak, B.A. (2005b). Searching for evidence-based medicine in the literature. Part 3: Assessment. Clinical Medicine & Research, 3(2), 113-115.
r-4. Butcher, L. (2006, October). Evidence-based medicine gets a push from businesses. Managed Care. Retrieved November 24, 2006 from http://www.managedcaremag.com/archives/0610/0610.employers.html.
r-5. Cocosila, M., & Archer, N. (2006). Physician interaction with mobile and wireless handheld devices: Data entry and retrieval challenges. International Journal of Healthcare Technology and Management, 7(3/4), 233-251.
r-6. Eddy, D.M. (2005). Evidence-based medicine: A unified approach. Health Affairs 24(1), 9-17. Retrieved October 14, 2006, from Academic Search Premier.
r-7. Exec. Order No. 13335, 3 C.F.R. 161-162 (2004). Retrieved October 13, 2006, from http://a257.g.akamaitech.net/7/257/2422/20jan20050800/edocket.access.gpo.gov/cfr_2005/janqtr/3CFR13335.htm.
r-8. Garg, A.X., Adhikari, N.K.J., McDonald, H., Rosas-Arellano, M.P., Devereaux, P.J., Beyene, J., Sam, J., & Haynes, R.B. (2005). Effects of computerized clinical decision support systems on practitioner performance and

patient outcomes: A systematic review. Journal of the American Medical Association 293(10), 1223-1238.
r-9. Goldschmidt, P.G. (2005). HIT and MIS: Implications of health information technology and medical information systems. Communications of the ACM, 48(10), 69-74. Retrieved October 8, 2006, from Academic Search Premier.
r-10. Hurwitz, S.R., Tornetta, P. & Wright, J.G. (2006). How to read the literature to change your practice: An evidence-based medicine approach. The Journal of Bone & Joint Surgery 88A(8), 1873-1879.
r-11. Institute of Medicine. (1999, November). To err is human: Building a safer health system. Report brief retrieved October 13, 2006, from http://newton.nap.edu/html/to_err_is_human/reportbrief.pdf.
r-12. Institute of Medicine. (2001, March). Crossing the quality chasm: A new health system for the 21 st century. Report brief retrieved October 13, 2006, from http://www.iom.edu/Object.File/Master/27/184/Chasm-8page.pdf.
r-13. Kaiser Permanente's Care Management Institute. (n.d.). Making the right thing easier to do [Brochure]. Wallace, P: Author. Retrieved November 24, 2006 from http://www.kpcmi.org/products/brochure.pdf.
r-14. Krauskopt, P.B. (2006). Even techno-phobic NPs can use PDAs. The Nurse Practitioner 31(7), 48-52. Retrieved October 29, 2006, from Academic Search Premier.
r-15. Lu, Y.C., Xiao, Y., Sears, A. & Jacko, J.A. (2005). A review and a framework of handheld computer adoption in healthcare. International Journal of Medical Informatics 74, 409-422. Retrieved October 29, 2006, from Science Direct.
r-16. Mendelson, D., & Carino, T. (2005). Evidence-based medicine in the United States – de rigueur or dream deferred? Health Affairs 24(1), 133-136. Retrieved October 8, 2006, from Academic Search Premier.
r-17. Shannon, T., Feied, C., Smith, M., Handler, J., & Gillam, M. (2005). Wireless handheld computers and voluntary utilization of computerized prescribing systems in the emergency department. Journal of Emergency Medicine, 31(3), 309-315. Retrieved October 8, 2006, from Academic Search Premier.
r-18. Short, D., Frischer, M., & Bashford, J. (2004). Barriers to the adoption of computerized decision support systems in general practice consultations: a qualitative study of GPs' perspectives. International Journal of Medical Informatics, 73, 357-362. Retrieved October 8, 2006, from Academic Search Premier.
r-19. Straus, S.E., Richardson, W.S., Glasziou, P., & Haynes, R.B. (2005). Evidence-based medicine: How to practice and teach EBM (3 rd ed.). Philadelphia: Elsevier Churchill Livingstone.

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