

A Bio-medical Informatics Perspective on Human Factors

Understanding Human Factors Influence in HIT-enabled Institutions

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Summary

Objectives: To summarize current excellent research in the field of bio-medical informatics human factors.

Methods: We provide a synopsis of the articles selected for the IMIA yearbook 2009, from which we attempt to derive a synthetic overview of the activity and new trends in the field. A special attention was made to pick papers also from non bio-medical informatics specialized journals and to perform a worldwide selection.

Results: while the state of the research in the field of human factors is illustrated by a set of fairly heterogeneous studies, it is possible to identify trends. Thus, clearly, the importance of issues related to healthcare information technologies (HIT) adoption, still occupies a central role in the field.

Conclusions: Convincing the clinicians of the HIT potential gains is still a challenge. But the HIT community will also have to give birth to interdisciplinary research and clear methods to optimize implementations and subsequent achievement of managerial objectives. The best paper selection of articles on human factors shows examples of excellent research on methods concerning original options to once again assess the importance of HIT and take into account the healthcare personnel psychology when confronted to the adoption of new tools and processes.

Keywords

Medical informatics, International Medical Informatics Association, yearbook, human factors

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Introduction

Since the 1991 Institute of Medicine recommendations [1-2] electronic health records (EHRs) are supposed to support patient care, improve quality of care, enhance productivity of healthcare professionals, support research, accommodate future developments and ensure confidentiality. Many studies gave strong evidences of medication errors and adverse drug events reduction following a CPOE implementation [3-5]. However, despite these evidences adoption of Healthcare Information Technologies (HIT) in hospitals has been slow due to many factors including: the high cost of purchase-implementation-maintenance of systems, the immaturity of software products, the lack of integration between EHR systems, the medical staff resistance, the emergence of new mortality and morbidity causes [6-16]. Studies are showing a gap between medical teams perceived value of EHR systems and their intent to adopt this practice [17]. Most of the teams are reluctant to cross the gap on the perception that HIT are time-inefficient or a major time-consuming system [6,18-24].

Best Paper Selection

The best paper selection of articles for the section on human presents excellent research on methods used for the analysis of interaction and communication between healthcare agents, between healthcare computer systems and professionals. For the IMIA Yearbook 2009 papers selection was accomplished from the classical healthcare informatics jour-

nals but not only. A large number non bio-medical informatics specialized journals were examined and we tried to perform an as broad as possible worldwide selection. The six papers selected this year, clearly address different aspects of the HIT adoption issues and how this adoption could become successful. Three of the papers are directly related to specific evidence of the HIT benefits. Hertzum and al. assessed that in the right environment clinicians will clearly experience EHRs' benefits during team conferences, ward rounds and nursing handovers. Narasimhadevara and al. successfully implemented a system supporting the activities of transplant nurses leading to the replacement of manual methods of working. Sward and al. captured physicians declining from a clinical decision support system to implement a protocol validation and refinement process. The three other papers are more strategic views. Yusof and al. reviewed HIT systems papers trying to assess to which extent they are fulfilling their objectives. Lin and al. reviewed the literature and developed a research design to show the factors that impact the effectiveness of virtual teams. And finally Greenhalgh and al. showed that EHRs are complex innovations heavily influenced by individuals' attitudes and concerns, and interpersonal influence. Table one presents the selected papers. A brief content summary of the selected best papers can be found in the appendix of this report.

Conclusion and Outlook

The best paper selection for the Yearbook section 'human factors' can by no means

reflect the broadness of a field that is heterogeneous and published in a large collection of journals not only bio-informatics or clinically centered. The selected papers, however, shed light on some special aspects deserving particular attention as they will still concern organizational and methodological questions in the near future. As already stated last year in this section [25], the current HIT research shows a need for consolidation in terms of integrating human factors in computerized healthcare institutions, as well as in routine health policy management. Performing this task correctly will represent a major step in closing the HIT implementation chasm [26]. The best paper selection of articles on human factors shows examples of excellent research on methods concerning original development as well as new assessments deriving of previously reported studies. In the context of the ARRA HIT stimulus act of 2009 [27], US hospitals will lead the way to experiment strong EHR adoption at a country level. This new HITECH era will certainly broaden the data already available to best take into account the human factor in hospitals projects keeping in mind that bio-informatics is here to serve us, not the opposite.

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Table 1 Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2009 in the section 'Human Factors'. The articles are listed in alphabetical order of the first author's surname.

Section
Human Factors
<ul style="list-style-type: none"> ■ Greenhalgh T, Stramer K, Bratan T, Byrne E, Mohammad Y, Russell J. Introduction of shared electronic records: multi-site case study using diffusion of innovation theory. <i>BMJ</i> 2008 Oct 23;337:a1786. ■ Hertzum M, Simonsen J. Positive effects of electronic patient records on three clinical activities. <i>Int J Med Inform</i> 2008 Dec;77(12):809-17. ■ Lin C, Standing C, Liu Y-C. A model to develop effective virtual teams. <i>Decision Support Systems</i> 2008;45:1031-45. ■ Narasimhadevara A, Radhakrishnan T, Leung B, Jayakumar R. On designing a usable interactive system to support transplant nursing. <i>J Biomed Inform</i> 2008 Feb;41(1):137-51. ■ Sward K, Orme J Jr, Sorenson D, Baumann L, Morris AH; Reengineering Critical Care Clinical Research Investigators. Reasons for declining computerized insulin protocol recommendations: application of a framework. <i>J Biomed Inform</i> 2008 Jun;41(3):488-97. ■ Yusof MM, Papazafeiropoulou A, Paul RJ, Stergioulas LK. Investigating evaluation frameworks for health information systems. <i>Int J Med Inform</i> 2008 Jun;77(6):377-85.

Appendix: Content Summaries of Selected Best Papers for the IMIA Yearbook 2009, Section Human Factors*

Hertzum M, Simonsen J

Positive effects of electronic patient records on three clinical activities

Int J Med Inform 2008 Dec; 77(12):809-17

Purpose: In this paper the authors investigate the effects of a fully functional electronic patient record (EPR) system on clinicians' work during team conferences, ward rounds, and nursing handovers. **Method:** In collaboration with clinicians they configured an EPR system for a stroke unit and put it in trial use for 5 days, 24h a day. During the trial period the EPR system was used by all clinicians at the stroke unit and it replaced all paper records. The EPR system simulated a fully integrated clinical-process EPR where the clinicians experienced the system as if all transactions were IT supported. Such systems are not to be expected to be in operational use in Denmark until at least 2 years from now. The EPR system was evaluated with respect to its effects on clinicians' mental workload, overview, and need for exchanging information. Effects were measured by comparing the use of electronic records with the use of paper records prior to the trial period. The data comprise measurements from 11 team conferences, 7 ward rounds, and 10 nursing handovers. **Results:** During team conferences the clinicians experienced a reduction on five of six subscales of mental workload, and the physicians experienced an overall reduction in mental workload. The physician in charge also experienced increased clarity about the importance of and responsibilities for work tasks, and reduced mental workload

* The complete papers can be accessed in the Yearbook's full electronic version, provided that permission has been granted by the copyright holder(s).

during ward rounds. During nursing handovers the nurses experienced fewer missing pieces of information and fewer messages to pass on after the handover. Further, the status of the nursing plans for each patient was clearer for all nurses at the nursing handovers except the nurse team leader, who experienced less clarity about the status of the plans. **Conclusion:** they conclude stating that the clinicians experienced positive effects of electronic records over paper records for the three clinical activities involved in the evaluation. This is important in its own right and likely to affect clinicians' acceptance of EPR systems, their command of their work, and consequently the attainment of 'downstream' effects on patient outcomes.

Narasimhadevara A, Radhakrishnan T, Leung B, Jayakumar R

On designing a usable interactive system to support transplant nursing

J Biomed Inform 2008 Feb;41(1):137-51

Purpose: This paper is based on the fact that solid organ transplant has been steadily increasing in number both nationally and internationally. Caring for the transplant patients in the hospital setting, right after the patient is moved from the intensive care unit to the ward, is one of the most challenging tasks in nursing. It involves many procedures, rigid protocols, tight monitoring, and intensive data gathering for use by the other coordinating healthcare professionals. The complexity is further increased when a nurse has to take care of several transplant patients in a single shift. Of late, there has been a growth of computer applications in nursing and clinical information systems. Their acceptability and usability determine the ultimate success of computer support for this complex task. **Method:** In this paper, they present a case study in which they combine two well-known software engineering techniques—namely, agile programming and user centered design—toward the goal of developing an interactive system for supporting the activities of transplant nurses in a hospital setting. **Results:** This has resulted in a usable end-product and the user centered approach has

motivated the nurses to move towards the use of computers in their jobs for better productivity. The product's usability was formally evaluated and is reported herein.

Conclusions: The strengths and limitations of this approach are also discussed. The software product developed has been well accepted and is currently being planned to replace the manual methods followed in the transplant ward of a large metropolitan hospital.

Sward K, Orme J Jr, Sorenson D, Baumann L, Morris AH

Reasons for declining computerized insulin protocol recommendations: Application of a framework

J Biomed Inform 2008 Jun;41(3):488-97

Purpose: This paper is based on the assessment that clinical decision support systems (CDS) can interpret detailed treatment protocols for ICU care providers and that in open-loop systems, clinicians can decline protocol recommendations. The authors captured their reasons for declining as part of ongoing, iterative protocol validation and refinement processes. **Method:** They identified and categorized reasons documented by ICU nurses when declining recommendations from an insulin-titration protocol. Two methods were used to operationalize the framework: reasons for declining recommendations from actual software use, and a nurse questionnaire. **Results:** Even though their protocol was well-accepted by clinicians overall, non-compliance patterns revealed potential protocol improvement targets, and suggested ways to reduce barriers impeding software use. **Conclusions:** Applying the framework exposed limitations of their data sources, suggested ways to address those limitations; and facilitated their analysis and interpretation.

Yusof MM, Papazafeiropoulou A, Paul RJ, Stergioulas LK

Investigating evaluation frameworks for health information systems

Int J Med Inform 2008 Jun;77(6):377-85

Purpose: This paper presents an overview of evaluation in health informatics and

information systems. Evaluation of health information systems (HIS) enables the assessment of the extent to which HIS are fulfilling their objectives in supporting the services of healthcare delivery.

Methods: The authors used literature review on discourses, dimensions, and methods of HIS evaluation. A critical appraisal of selected HIS evaluation frameworks has been undertaken in order to identify relevant dimensions and measures. The frameworks were compared based on their inclusion of human, organizational and technological factors.

Results: They found that an increasing number of evaluation studies deal with two distinct trends of HIS: one considers human and organizational issues and the other is concerned with the employment of a subjectivist approach. Their review indicates that current evaluation methods complement each other in that they evaluate different aspects of HIS and they can be improved upon. **Conclusions:** They conclude stating that evaluation is complex; it is easy to measure many things but not necessarily the right ones. Nevertheless, it is possible to consider a HIS evaluation framework with more comprehensive and specific measures that would incorporate technological, human and organizational issues to facilitate HIS evaluation.

Lin C, Standing C, Liuc YC

A model to develop effective virtual teams

Decision Support Systems 2008

Nov;45(4):1031-1045

Purpose: Lin, Standing and Liuc made an excellent review of the literature showing that the factors that impact on the effectiveness of virtual teams are still ambiguous. **Method:** To address this problem they developed a research design that included a meta-analysis of the literature, a field experiment and a survey. The meta-analysis identified factors which impact on the effectiveness of virtual teams which were then validated by a field experiment and the survey. **Results:** The results of the study indicate that social dimensional factors need to be considered early on in the virtual team

creation process and are critical to the effectiveness of the team. **Conclusion:** Communication is a tool that directly influences the social dimensions of the team and in addition the performance of the team has a positive impact on satisfaction with the virtual team.

A major contribution of the paper is an integrated model of factors that contribute to virtual team effectiveness.

Greenhalgh T, Stramer K, Bratan T, Byrne E, Mohammad Y, Russell J

Introduction of shared electronic records: multi-site case study using diffusion of innovation theory

BMJ 2008;337:a1786

Purpose: In this paper the authors explore the introduction of a centrally stored, shared electronic patient record (the summary care record - SCR) in England and draw wider lessons about the implementation of large scale information technology projects in healthcare. **Method:** They used multi-site, mixed method case study applying utilization focused evaluation. Their data came from four early adopter sites for the SCR in England—three in urban areas of relative socioeconomic deprivation and the fourth in a relatively affluent rural area. This gave them a collection of 250 staff interviews, 1500 hours of ethnographic observation, interviews and focus groups with 170 patients and healthcare professionals, 2500 pages of correspondence and documentary evidence, and incorporation of relevant surveys and statistics produced by others. These were analyzed by using a thematic approach drawing on (and extending) a theoretical model of complex change developed in a previous systematic review.

Results: They found that the mixed fortunes of the SCR program in its first year were largely explained by eight interacting influences. The first was the SCR's material properties (especially technical immaturity and lack of interoperability) and attributes (especially the extent to which potential adopters believed the benefits outweighed the risks). The second was adopters' concerns (especially

about workload and the ethicality of sharing "confidential" information on an implied consent model). The third influence was interpersonal influence (for example, opinion leaders, champions, facilitators), and the fourth was organizational antecedents for innovation (for example past experience with information technology projects, leadership and management capacity, effective data capture systems, slack resources). The fifth was organizational readiness for the SCR (for example, innovation-system fit, tension for change, power balances between supporters and opponents, baseline data quality). The sixth was the implementation process (including the nature of the change model and the extent to which new routines associated with the SCR aligned with existing organizational routines). The seventh influence was the nature and quality of links between different parts of the system, and the final one was the wider environment (especially the political context of the program). **Conclusion:** They conclude stating that shared electronic records are not plug-in technologies. They are complex innovations that must be accepted by individual patients and staff and also embedded in organizational and interorganizational routines. This process is heavily influenced at the micro-level by the material properties of the technology, individuals' attitudes and concerns, and interpersonal influence; at the micro-level by organizational antecedents, readiness, and operational aspects of implementation; and at the macro-level by institutional and socio-political forces. A case study approach and multi-level theoretical analysis can illuminate how contextual factors shape, enable, and constrain new, technology supported models of patient care.

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