

# A Bio-Medical Informatics Perspective on Human Factors

## Findings from the Yearbook 2008 Section on Human Factors

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### Summary

**Objectives:** To summarize current excellent research in the field of human factors.

**Methods:** We provide a synopsis of the articles selected for the IMIA Yearbook 2008, from which we attempt to derive a synthetic overview of the activity and new trends in the field.

**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 medical order entry, which also founded human factors studies in medical informatics, still occupies a central role in the field. In parallel, we observe an emerging interest for human factors from the field of bioinformatics, where the mass of data generated by high/throughput experiments and large-scale genome analysis projects, raises specific processing challenges. Such challenges will have to be addressed to achieve post-genomics era medicine.

**Conclusions:** The best paper selection of articles on human factors shows examples of excellent research on methods concerning original development as well as quality assurance of previously reported studies. The crucial role of preserving interpersonal communication among healthcare staff in computerized working environments is complemented by more original scientific investigations, which demonstrate the needs for computerized applications to transform the biomedical data overflow into more operational clinical knowledge. Altogether these papers support the idea that more elaborated computer tools, likely to combine contextual contents, are needed.

### Keywords

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

Geissbuhler A, Kulikowski C, editors. IMIA Yearbook of Medical Informatics 2008. *Methods Inf Med* 2008; 47 Suppl 1: 41-3

## Introduction

The four papers selected this year, clearly address different aspects of human factors. Beuscart-Zephir's paper reports on a qualitative comparison of physician-nurse interactions in two different settings: synchronous interaction vs. delayed interaction. In a related and complementary vein, the two next papers study order entry-related issues. Complementing the human-human interactions studies in the first selected paper, these studies focus on studying computer-mediated interactions: Holden et al. proposes a comprehensive review on the Computerized Provider Order Entry (CPOE), while Weir et al. study the problem in the specific context of the Veteran Affairs Administration System. The last paper address an orthogonal problem, yet directly related to human factors: Baumgartner et al.'s results suggest that given the size of the data to be processed, human-curated databases in life sciences, and in particular in molecular biology, will demand resources and efforts over decades. Thus, it justifies the use of literature-based automated approaches for functional annotation of gene and gene products [1] or for phenotype annotation [2].

## Best Paper Selection

The best paper selection of articles for the section on human factors in the

IMIA Yearbook 2008 follows the tradition of previous Yearbooks in presenting excellent research on methods used for the analysis of interaction and communication between healthcare agents, between healthcare computer systems and professionals, as well as for biomedical database curation. Three of the papers are directly related to an increasing corpus of well-documented experiments dedicated to the study of physician-nurse communication and interactions between professionals. The primary objective here is to reduce errors in the care processes [3]. Given the important proportion of papers focusing on studying those interactions either via electronic reports or based on papers, it might not be exaggerated to define drug-prescription and - to some extent healthcare in general - as an interactive paper generation process! We also can measure the remaining impact of seminal studies such as [7] in the field. Baumgartner et al.'s paper clearly demonstrates how the whole genome analysis project could be described as an "asynchronous and massively distributed communication process" between a wide span of specialists, including biologists, experimentalists, bioinformaticians, librarians, and knowledge engineers. Table 1 presents the selected papers. A brief content summary of the selected best papers can be found in the appendix of this report.

**Table 1** Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2008 in the section 'Human Factors'. The articles are listed in alphabetical order of the first author's surname.

Section
<b>Human Factors</b>
<ul style="list-style-type: none"> <li>▪ Baumgartner WA Jr., Cohen KB, Fox LM, Acquaaah-Mensah G, Hunter L. Manual Curation is not Sufficient for Annotation of Genomic Databases. <i>Bioinformatics</i> 2007;23:4-8.</li> <li>▪ Beuscart-Zéphir MC, Pelayo S, Anceaux F, Maxwell D, Guerlinger S. Cognitive Analysis of Physicians and Nurses Cooperation in the Medication Ordering and Administration Process. <i>Int J Med Inform</i> 2007 Jun;76 Suppl 1:65-77.</li> <li>▪ Holden RJ, Karsh BT. A Review of Medical Error Reporting System Design Considerations and a Proposed Cross-level Systems Research Framework. <i>Hum Factors</i> 2007 Apr;49(2):257-76.</li> <li>▪ Weir CR, Nebeker JJ, Hicken BL, Campo R, Drews F, Lebar B. A Cognitive Task Analysis of Information Management Strategies in a Computerized Provider Order Entry Environment. <i>J Am Med Inform Assoc</i> 2007 Jan-Feb;14(1):65-75.</li> </ul>

## Conclusions and Outlook

The best paper selection for the Yearbook section 'human factor' can by no means reflect the broadness of a field that is intrinsically heterogeneous. The selected papers, however, shed light on some special aspects deserving particular attention as they concern methodological questions in the near future. A period of rapid development in the realm of electronic health records, with products being now available off-the-shelf has lead to extensive and fruitful experimental works in the field. The current state shows a need for consolidation in terms of integrating human-factors in computerized healthcare institutions, as well as in routine health policy management.

The best paper selection of articles on human factors shows examples of excellent research on methods concerning original development as well as quality assurance of previously reported studies. The crucial role of preserving interpersonal communication in healthcare staff in computerized working environments is complemented by more original scientific investigations, which demonstrate the needs for computerized applications to translate the biomedical data overflow into operational clinical knowledge. Altogether

these papers support the idea that more elaborated computer tools, likely to combine con-textual contents, are needed.

The years to come will probably show more and more studies demonstrating that a new generation of intelligent computer tools can help health and life science professionals in an ever growing range of tasks such as medical encoding [4], database curation [5], and ultimately also in core healthcare situations such as drug prescription and administration [6].

### Acknowledgement

I greatly acknowledge the support of Martina Hutter and of the reviewers in the selection process of the IMIA Yearbook. I also would like to thank Casimir Kulikowski for the enlightened discussions we had during the selection process.

### References

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the assignment of diagnosis codes to patient encounters using example-based and machine learning techniques. *J Am Med Inform Assoc*. 2006 Sep-Oct;13(5):516-25. Epub 2006 Jun 23.

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## Appendix: Content Summaries of Selected Best Papers for the IMIA Yearbook 2008, Section Human Factors\*

**Beuscart-Zéphir MC, Pelayo S, Anceaux F, Maxwell D, Guerlinger S**

**Cognitive Analysis of Physicians and Nurses Cooperation in the Medication Ordering and Administration Process**

*Int J Med Inform* 2007 Jun;76 Suppl 1:65-77

**Purpose:** This article aims at studying the physician-nurse cooperation in a medication ordering task for a cognitive perspective. The authors compared two paper-based work organizations characterized by: a synchronous coop-

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

eration engendered by common doctor-nurse medical rounds, and an asynchronous situation characterized by split physician's and nurse's rounds. **Methods:** They rely on a theoretical model and use ergonomics methods to analyse physicians' and nurses' activities. **Results:** The analysis of doctor-nurse dialogues demonstrated that in the synchronous mode, the nurses directly participated in the medication ordering process. Although paper-based analysis showed that the orders were not fully documented, interviews with the nurses demonstrated that nurses were able to disambiguate the physician's prescription intentions. In this synchronous work, the nurse was able to interpret the content of the medication administration process. In the asynchronous situation, the results were reversed. The asynchronous situation is very similar to the CPOE situation, where the coordination of physicians' and nurses' actions was delegated to the system. **Conclusion:** The paper concludes that organizational and cognitive aspects should be considered when designing CPOE systems.

**Baumgartner WA Jr., Cohen KB, Fox LM, Acquah-Mensah G, Hunter L**

#### **Manual Curation is not Sufficient for Annotation of Genomic Databases**

**Bioinformatics 2007;23:41-8**

**Background:** Construction of Knowledge base has been an area of major importance in the recent growth and success of computational biology. There is little work dedicated to the evaluation of knowledge base contents regarding the time needed to achieve a comprehensive achievement of these databases. **Purpose and Methods:** In this scientific report, the authors propose to

apply an original metric, the found/fixed graph, to the problem of evaluating the processes by which genomic knowledge bases are built, as well as the comprehensiveness of their contents. **Results:** Well-understood patterns of change in the found/fixed graph are found to occur in two large publicly available knowledge bases: Swiss-Prot and Entrez-Gene. **Conclusion:** The article concludes that the current manual curation processes will take far too long to complete the annotations of even just the most important model organisms.

**Holden RJ, Karsh BT**

#### **A Review of Medical Error Reporting System Design Considerations and a Proposed Cross-level Systems Research Framework**

**Hum Factors 2007 Apr;49(2):257-76**

**Background:** The authors observe that medical errors are a major cause of death among adults in the United States. However, no comprehensive review exists to synthesize the state of the art to achieve successful reporting systems. **Purpose:** The paper reviews the literature on medical error reporting systems, identifies gaps in the literature, and presents a model to help designing better applications. **Methods:** For the study the authors have screened several digital libraries to identify key articles. From them, references to other relevant articles were searched. **Results:** The survey identified components of medical error reporting systems, error reporting system design choices, barriers and incentives for reporting. The authors proposed suggestions for successful reporting system design and observe the relative poorness of theoretical foundations. The authors suggest a framework for understanding the medical error reporting literature. **Conclu-**

**sion:** The authors provide some guidance for designing more effective reporting systems, but they conclude that more research is needed on the subject.

**Weir CR, Nebeker JJ, Hicken BL, Campo R, Drews F, Lebar B**

#### **A Cognitive Task Analysis of Information Management Strategies in a Computerized Provider Order Entry Environment**

**J Am Med Inform Assoc 2007 Jan-Feb; 14(1):65-75**

**Background:** Within the past years, clinicians have seen their working environment modified by Computerized Provider Order Entry (CPOE) and computerized decision support instruments. Traditional information exchange media, based on papers and verbal communication have been replaced by computerized systems. **Purpose:** In this paper, the authors explore how clinicians adapt to CPOE system using cognitive task analysis techniques. **Methods:** Both semi-structured interviews and observations are performed with a population of clinicians (N=88) at ten different Veterans Administration Medical Centers. Analysis of the interviews was made to identify key information management goals, strategies, and tasks. Tasks were clustered into subsets to highlight underlying goals and strategies. **Results:** No more than half of the identified tasks were supported by existing computer tools. The four following goals were identified: 1) Relevance Screening; 2) Ensuring Accuracy; 3) Minimizing memory load; and 4) Negotiating Responsibility. **Conclusion:** Information technology users develop a wide range of strategies to adapt to new tools, but it is important to facilitate their adaptation to succeed in deploying CPOE applications.