From Bench to Bed: Bridging from Informatics Theory to Practice

An Exploratory Analysis

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Summary
Background: In 2009, the journal Applied Clinical Informatics (ACI) commenced publication. Focused on applications in clinical informatics, ACI was intended to be a companion journal to Methods of Information in Medicine (MIM). Both journals are official journals of IMIA, the International Medical Informatics Association.

Objectives: To explore, after five years, which congruencies and interdependencies exist in publications of these journals and to determine if gaps exist. To achieve this goal, major topics discussed in ACI and in MIM had to be analysed. Finally, we wanted to explore, whether the intention of publishing these companion journals to provide an information bridge from informatics theory to informatics practice and from practice to theory could be supported by this model. In this manuscript we will report on congruencies and interdependencies from practise to theory and on major topics in ACI. Further results will be reported in a second paper.

Methods: Retrospective, protective observational study on recent publications of ACI and MIM. All publications of the years 2012 and 2013 from these journals were indexed and analysed.

Results: Hundred and ninety-six publications have been analysed (87 ACI, 109 MIM). In ACI publications addressed care coordination, shared decision support, and provider communication in its importance for complex patient care and safety and quality. Other major themes included improving clinical documentation quality and efficiency, effectiveness of clinical decision support and alerts, implementation of health information technology systems including discussion of failures and successes. An emerging topic in the years analyzed was a focus on health information technology to predict and prevent hospital admissions and managing population health including the application of mobile health technology. Congruencies between journals could be found in themes, but with different focus in its contents. Interdependencies from practise to theory found in these publications, were only limited.

Conclusions: Bridging from informatics theory to practise and vice versa remains a major component of successful research and practise as well as a major challenge.

1. Introduction

In 2008, a call for an applied clinical informatics journal was published in Methods of Information in Medicine (MIM) [1] as a result of an increasing demand for research and information focusing on the implementation and maintenance of bedside health information systems that had been perceived. Subsequently, in late 2009, Applied Clinical Informatics (ACI) started to publish papers in the core domains of clinical information systems, administrative and management systems, eHealth systems, information technology development, deployment, and evaluation, socio-technical aspects of information technology (IT) and health IT training [2, 3].

Five years after the launch of ACI, an opportunity to explore the content of MIM and ACI in relationship was grasped, to investigate if informatics theory and methods (as reflected in MIM) were developing in parallel to the application of the science (as reflected in ACI) and to explore which congruencies and which interdependencies exist.

2. Questions

The following research questions were raised:

* Which congruencies and which interdependencies exist
  - (tp)from theory to practice? (I.e., in this context, from content reported in MIM to content published in ACI.)
  - (pt)from practice to theory? (I.e., in this context, from content reported
in ACI to content published in MIM.)

And what are existing gaps?

To answer these questions, we first needed to know
- Which major topics were being discussed
  - (a) in ACI?
  - (m) in MIM?

The final question was:
(b) Can the intent to bridge knowledge from informatics theory to informatics practice be supported by this model of companion journals?

The study design for our investigation is presented in the next section. Answers to questions (a) and (tp) will be treated in this paper in sections 4.1 and 4.2 (as being of major interest to the readership of this journal), those for questions (m) and (pt) are presented in ACI [4]. Reflections on question (b) will be discussed in both papers in section 4.3. To increase the ease of reading, we have almost identically sections 1–3 and sections 5 and 6 in both papers, being aware that this will generate some redundancy.

### 3. Material and Methods

The study design chosen was that of a retrospective, but prolective observational study (cf. [5] on the differences of pro/retro-spective and -lective).

As empirical basis for the intended analysis, the authors decided to evaluate all publications, which appeared in the years 2012 and 2013 in ACI (ACI volumes 3 in 2012 and 4 in 2013, journal information at [6]) and in MIM (MIM volumes 51 in 2012 and 52 in 2013, journal information at [7]).

Both journals are official journals of IMIA, the International Medical Informatics Association [8] and both are published by the same publisher, Schattauer Verlag, Stuttgart, Germany [9].

Publications were defined as journal articles excluding editorials and letters to the editor. To identify these publications we used Medline/PubMed [10], specifying as time limits January 1, 2012, until December 31, 2013, and as journals ACI and MIM. The Medline/PubMed search was done on September 21, 2014. From the reference list obtained, we excluded all editorials and all electronic publications to be printed later than 2013. The number of publications in the respective years is presented in Table 1.

To analyse these publications with respect to the research questions raised in section 2, all respective publications were indexed. Complying with rules for good scientific practise (e.g. [11]), all indexing data and observations, recorded by the authors as basis for this publication, have been stored. Copies of the files can be requested from the authors. All analysed publications can be accessed through the respective publishing company’s web site mentioned above or in case of ACI through PubMedCentral [12].

### 4. Results

#### 4.1 Major Topics Discussed in ACI

ACI’s editorial focus is on the application of informatics research in the interface between providers, patients, and IT systems used in the management of care. As such, the editorial team favours manuscripts that focus on the practical applied aspects of clinical informatics and allow readers to learn from success and failures in implementation, design, maintenance, and upkeep of clinical information systems. ACI will publish negative results or outright failures of clinical informatics projects.

The themes of topics addressed in published manuscripts in ACI between 2012 and 2013 were wide. While the following summary of accepted manuscripts does not reflect the complete content, it is a representative subset.

One major theme was the topic of care coordination and provider communication. The increasing complexity of patients and the increase in patients with multiple conditions that require coordination of care by multiple specialties and across provider types created interest in how to leverage electronic health records (EHRs) and other clinical informatics tools in the improvement of care. Papers addressed identification of information needs to allow knowledge sharing and distributed decision making [13], and utilization of tools like clinical decision support (CDS) [14], health risk assessments [15] or email [16] to enhance care coordination. Designs that improved communication of administrative data but failed to improve clinical relevant data exchange were discussed [17].

Assuring that the right information is conveyed was reflected in work related to clinical documentation on improving summarizing of clinical content [18], domain specific structured note design [19] that can facilitate earlier disease staging and education [20], enforcing of inclusion of pending test results in discharge notes [21], automatic inclusion of data into documentation [22], documentation of ambulance encounters [23], dealing with eponyms in documentation [24], tools to assess the quality of documentation [25], and the consensus paper by the Association of Medical Directors of Information Systems on clinical documentation practices [26].

Clinical decision support and alert quality and fatigue were major topics for 2012 and 2013. Clinical decision support efforts included order sets to improve standardization of care [27] and to reduce falls [28] but also addressed unintended consequences of order sets [29], the design flaws of CDS such as lack of clues, information at the wrong time, and ambiguity [30], failure of CDS to improve appropriate prescribing at discharge [31], the challenges to imple-
ment black box warnings [32] and the not surprising but sobering realization that using CDS to enforce bad policies does not improve outcomes [33].

CDS to improve quality measures in maternal care [34], reduce pressure ulcers [35], detect adverse vaccination events [36] and acute kidney injury [37], provide antibiotic decision support [38], improve laboratory follow up of patients on high risk medications [39], and monitoring of adherence to clinical guidelines [40] were discussed.

Papers addressed design features to improve the usefulness of alerts [41], causes and mitigation of false alerts [42], and the value of interruptive versus non-interruptive alerts for contact isolation [43]. While provider demographics were found not to account for failure to adhere to CDS alerts [44], other papers discussed ways to reduce alert fatigue including in patients with abnormal laboratory values [45].

Another major theme included implementation of health information technology (HIT). Topics included usability of information systems [46–48], their under-appreciated effectiveness [49], factors influencing HIT systems use [50, 51] and implementation success [52–54], as well as tools like visualization [55] to improve usability. An important sub-topic was the discussion of replacing an existing HIT system [56, 57], managing more than one EHR system at the same time [58].

Predicting outcomes of patient populations and population management were two important topics. Considering the considerable financial pressure in the US, using HIT to predict readmission of patients [59] or admission of home care patients [60] was considered important. Managing populations was reflected by papers on immunization reporting to registries [61]. Several papers discussed tools to improve [62], manage [28, 63], or better document [64, 65] the health of vulnerable populations such as children or older adults.

Rounding off the major themes where mobile health interventions [62, 66], which were mostly patient facing, and clinical informatics research related papers [67–71].

4.2 Congruencies and Interdependencies from Theory to Practice

Reviewing the publications of ACI and MIM for 2012 and 2013, it is apparent that there are both significantly overlapping topics and themes, but there are also major intriguing gaps.

A major theme that was addressed with similar emphasis in both journals was the topic of documentation. While MIM papers focused on novel approaches for patient records [72–75], ACI contributions were more focused on improving the efficiency and accuracy of documentation. Similarly, important themes such as computerized provider order entry systems [33, 76]), knowledge-based decision support [51, 77], health information systems [53, 78]), ambient-assisted living and telecare [55, 79] were addressed both in the methodological as well as the applied research spaces. Again, when examined closer, it however becomes apparent while the major topics are overlapping or congruent, both journals have different emphasis and focus even within a common theme. While ACI tries to answer questions such as “How can I prevent a patient becoming injured from a bad implementation?” or “How do I improve workflow to reduce provider burden?”, MIM addresses issues of communication of research results and discovery of novel models and methodologies. While we observed an overlap of major themes, it is not apparent that the theoretical work of MIM has influenced the practical research described in ACI in a significant manner yet nor did we observe the reverse.

Knowledge discovery was an important topic in MIM and while there were a few papers addressing this theme in ACI, there was a significant discrepancy in emphasis. Likely, medical imaging research on high performance methods [80, 81] and image analysis and modelling [82–84] as well as coding systems [85] were much more represented in MIM than in ACI.

4.3 Could the Intention to Support Bridging from Informatics Theory to Informatics Practice Be Supported by this Model of Companion Practice?

Based on the results presented in sections 4.1 and 4.2 in [4] and in this paper, we have to acknowledge that bridging from practice to theory through the two companion journals is limited. At least significant bridging could not be observed in the comparison of publications in both journals. As the readership of both journals is probably overlapping, we can assume that indirect interdependencies are given.

5. Discussion

Comparing two journals endorsed by the same international informatics society and published by the same publisher yielded interesting results. As much as we would have liked to report that the areas addressed in these two journals – one focused on theory and methods, the other focused on applied practice – were congruent and interdependent, the results did not permit this conclusion. This was even then the case when we excluded publications in MIM focusing on biostatistics and epidemiology (as the scope of MIM – stressing the methodology and scientific fundamentals of organizing, representing, and analyzing data, information, and knowledge in biomedicine and health care [7] extends beyond publications from biomedical and health informatics).

It is obvious that a clear need exists for the existence of both journals, since they cover important, relevant topics in both journals’ scopes. We were also able to observe some degree of overlap in content and major themes but were not able to see the desired pipeline of new insights from bench to bedside nor did we see the bench being informed by the bedside’s experience. For the editors of these two companion journals this may lead to modifications in their future editorial policy. Since the launch of ACI, the basic principle that we need a bridge from informatics theory to practice and vice versa – informing theory from the bedside – remains crucial for
progress in informatics practice and theory. Discovering novel ways on forcing the interaction between the different reader group including additional publication formats as well as targeted related publications that appear simultaneously in both journals may be helpful for future researchers and readers of these journals.

We are aware of several limitations of this exploratory analysis. Adding additional journals in the field may have been more informative and helpful, as well as including a more formal citation analysis. As we wanted to focus after five years of the launch of ACI on the aspects of the two companion journals of ACI and MIM, we finally decided to concentrate on the direct analysis of the contents (as being from our point of view of the highest priority) of the respective papers of these two journals only.

6. Conclusions

Bridging from informatics theory to practice and vice versa, as has been argued in [1–3], remains a major component of successful research and practice. Based of the results of our exploratory analysis, we have to acknowledge that these bridging goals remain far from achieved and will require additional efforts.

References

3. Haux R, Ball M. From Theory into Practice: Bridging the Clinical Informatics Divide! Appl Informatics 2009; 6: 8–11.
27. Haux R, Ball M. From Theory into Practice: Bridging the Clinical Informatics Divide! Appl Informatics 2009; 6: 8–11.