Improving Bridging from Informatics Practice to Theory

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Keywords
Clinical informatics, biomedical informatics, informatics practice, informatics theory

Summary
Background: In 1962, *Methods of Information in Medicine (MIM)* began to publish papers on the methodology and scientific fundamentals of organizing, representing, and analyzing data, information, and knowledge in biomedicine and health care. Considered a companion journal, *Applied Clinical Informatics (ACI)* was launched in 2009 with a mission to establish a platform that allows sharing of knowledge between clinical medicine and health IT specialists as well as to bridge gaps between visionary design and successful and pragmatic deployment of clinical information systems. Both journals are official journals of the International Medical Informatics Association. The objectives were to describe the major topics discussed in articles published in *ACI* in 2014 and to determine if there was evidence that theory in 2014 *MIM* publications was informed by practice described in *ACI* publications in any year. We also set out to describe lessons learned in the context of bridging informatics practice and theory and offer opinions on how *ACI* editorial policies could evolve to foster and improve such bridging.

Methods: We conducted a retrospective observational study and reviewed all articles published in *ACI* during the calendar year 2014 (Volume 5) for their main theme, conclusions, and key words. We then reviewed the citations of all *MIM* papers from 2014 to determine if there were references to *ACI* articles from any year. Lessons learned in the context of bridging informatics practice and theory and opinions on *ACI* editorial policies were developed by consensus among the two authors.

Results: A total of 70 articles were published in *ACI* in 2014. Clinical decision support, clinical documentation, usability, Meaningful Use, health information exchange, patient portals, and clinical research informatics emerged as major themes. Only one *MIM* article from 2014 cited an *ACI* article. There are several lessons learned including the possibility that there may not be direct links between *MIM* theory and *ACI* practice articles. *ACI* editorial policies will continue to evolve to reflect the breadth and depth of the practice of clinical informatics and articles received for publication. Efforts to encourage bridging of informatics practice and theory may be considered by the *ACI* editors.

Conclusions: The lack of direct links from informatics theory-based papers published in *MIM* in 2014 to papers published in *ACI* continues as was described for papers published during 2012 to 2013 in the two companion journals. Thus, there is little evidence that theory in *MIM* has been informed by practice in *ACI*.

1. Introduction

In 1962, *Methods of Information in Medicine (MIM)* began to publish papers on the methodology and scientific fundamentals of organizing, representing, and analyzing data, information, and knowledge in biomedicine and health care [1, 2]. Due to increased demand for research and information focusing on the implementation, improvement, and maintenance of bedside health information systems, 47 years later the journal *Applied Clinical Informatics (ACI)* was launched in 2009 [3–5]. Both journals are official journals of IMIA, the International Medical Informatics Association [6]. Published by the same publishing house [7], they can be viewed to some extent as companion journals intended to maintain and strengthen bridging from informatics theory to practice and vice versa on an international level [8, 9].

The American Recovery and Reinvestment Act incentive payments for the implementation of electronic health records (EHR) increased the relevance of applications in informatics and the successful launch of the U.S. clinical informatics board certification for physicians accelerated the recognition of *ACI* as an official journal of the American Medical Informatics Association, a little over five years after its launch.

In 2014, we explored congruencies and interdependencies in publications of *ACI* and *MIM* in the years 2012 and 2013 [10, 11]. We recognized that congruencies could be found in themes, but with different emphasis in its contents. Interdependencies from practice to theory as well as from theory to practice were only limited. We acknowledged that the bridging goals remained far from achieved. In this manuscript as well as in a companion paper [12], we set out to explore if the lack of associ-
2. Questions
This paper attempts to address the following questions:
1) Which major topics were being discussed in recent ACI publications?
2) Is there evidence that theory in MIM has been informed by practice in ACI?
3) Are there lessons learned in the context of bridging informatics practice and theory?
4) How could ACI editorial policies evolve to foster and improve bridging?

Our results for and/or answers to questions 1 to 4 can be found in sections 4 to 7.

3. Material and Methods
Consistent with the methodology used earlier, we conducted a retrospective observational study to answer the first question. Congruent with the analyses of 2012 and 2013, we searched for all ACI publications in the calendar year 2014 (volume 5). Publications were defined as journal articles excluding editorials and letters to the editor. To identify these publications we used a Medline/PubMed [13] query, specifying ACI as the journal and limiting the publication dates to include January to December, 2014. The Medline/PubMed search was performed on September 30, 2015. We retrieved a total of 73 publications through the search and excluded one editorial [14] and two special articles [10, 15] resulting in 70 publications included in the analysis. Papers were reviewed and indexed. Complying with rules for good scientific practice (e.g., [16]), all indexing data have been stored and may be requested from the authors. All analyzed publications can be accessed through the respective publishing company’s web site mentioned above and/or through PubMed Central [17].

For question 2 we analyzed the reference lists of all MIM articles printed in 2014 (excluding electronic papers to be printed after 2014 [29], editorials [8], letters to the editor [3] and [11] and searched the remaining 61 publications for references to articles published in ACI in any year. This was done using the find function across the reference lists of each MIM article on the MIM journal website [1] with the search term “Appl Clin Inform” and manually checking the reference lists in the printed journal issues.

Answers for questions 3 and 4 are based on the authors’ opinion and as such are subjective in nature.

4. Major Topics Discussed in ACI
Clinical Decision Support (CDS) was a major topic for 2014 ACI publications. A frequent theme was the poor performance of CDS tools for a variety of indications and settings including immunosuppressive therapy in transplant centers [18], medication administration and laboratory alerts in retirement/nursing homes [19, 20], as well as the continued high override rate of drug-drug alerts [21] requiring a tailoring of drug-drug alerts to specific user groups [22]. Very interesting work from Korea demonstrated that CDS cannot be just translated into other languages, but that there is a need to modify the CDS to account for cultural differences [23]. At the same time, ample evidence was provided on the success of CDS for a variety of tasks such as reducing and improving use of antimicrobials [24, 25], increasing the utilization of HIV testing [26], improving insulin-dosing in diabetics [27], preventing drug overdoses [28], improving scheduling [29], predicting readmission rates based on the patient’s medication regimen [30], predicting acute kidney injury [31], predicting patients with acute respiratory distress syndrome early [32], identifying adverse drug reactions from claims data [33], potentially reducing the risk for malpractice claims [34], and identifying foreign-born individuals [35]. The challenge of developing CDS from existing guidelines was highlighted with an analysis of the Bright Futures Guidelines, which were found to have only 52 actionable items [36].

Clinical documentation was another major topic of discussion. Topics ranged from purposes of documentation [37], required/desired data elements in EHRs [38, 39], representation of relatives in structure data format [40], data standardization [41], reasons for free text use [42] and the benefits of text prediction [43], and documentation quality [44] and timeliness [45] in relation to documentation method. Papers on ontology content as bridge for tobacco use information collected in heterogeneous systems [46] and SNOMED CT concept set visualization rounded out this topic [47].

One recurring topic focused on the age of the users or the patients when interacting with health information technology (HIT). There was overarching consensus that acceptance by younger users is higher in CDS [48], portal [49], and computerized provider order entry (CPOE) use [50]. User acceptance was a frequently discussed theme in e-prescribing systems [51] and two papers found that user interface design has a major impact on e-prescribing [52, 53]. Related to these findings were papers on usability of drug alerts [54], work flow analysis in diabetes [55], and user centered design of tools to document falls [56] or quality of life [57].

The impact of regulatory changes in the U.S. in the form of Meaningful Use (MU) legislation was a frequently discussed topic [21, 58]. Skepticism in the provider community that Meaningful Use will improve care [59] was joined with evidence of lack of usability of drug-drug alerts [21] and challenges to extract quality measures [60]. One paper explored length of stay (LOS) in conjunction with CPOE implementation mandated by MU and found a 20% reduction in LOS associated with CPOE adoption [61]. Funding for HIT was further found to improve quality measures and improved quality of care [62]. At the same time, EHR implementation [63] – a major feature of MU – was not associated with a reduction in readmissions [64]. One of the consequences of MU – the change to a new EHR vendor [65] – was addressed in a paper discussing data migration from one EHR to another [66].
Health Information Exchange (HIE) promoted by MU played a prominent role in 2014. Papers discussed HIE’s shortcomings [67] and benefits including its use in patient transfer [68] and in emergency departments [69, 70]. Cost of HIE to academic centers was also discussed [71].

Patient portals and personal health records have seen increased use in part due to Meaningful Use requirements [72]. Papers discussed novel portal content like problem lists and its effect on user satisfaction [73] and its use in screening for substance abuse [74]. The use of portals in managing hypertension was also discussed [75].

Telemedicine or telehealth applications were addressed in a paper which focused on its effect on improved adherence and reduced cost in heart failure [76]. Novel monitoring tools in Parkinson’s disease [77] and in the elderly using sensors [78] rounded out this topic.

Clinical research informatics saw an increase in publications in ACI in 2014. Topics included practical advice on tools like REDCap [79], recommendation for data cleaning [80], detecting adverse event signatures in reporting systems [81], designing patient recruitment systems [82], and contrasting target populations to actual patient populations [83].

Information retrieval [84, 85] and information seeking behavior were also discussed in the context of visit note display [86] and ignoring of content [87]. The increasing use of smartphones to access personal health information routinely was described [88].

5. Links from Practice to Theory

In 2014 Haux and Lehmann stated that bridging between both journals (ACI and MIM) was very limited although congruencies in themes could be found but with different emphasis [10, 11]. These statements were the results of analyzing ACI and MIM articles published during 2012–2013 by comparing articles during the same time period. Although ACI being a rather new journal had a cited half-life of 2.7 years in 2014 [89], it would be rather unusual to find links when comparing articles of the same year.

In addition to analyzing the topic descriptions of ACI, we therefore looked for evidence that ACI practice informed MIM theory by analyzing the reference lists in MIM publications. Analysis of the references of all MIM publications from 2014 except [11] revealed that only one MIM article [90] cited a paper from ACI [91] from any year. The ACI article that was cited described requirements of IT infrastructure components for bio-banking. In the MIM article, a new method for integrating collection protocols in bio-banking information systems was presented and some of the requirements detailed in the ACI article were taken into account. This example shows a possible direct link where practice is used to inform new theory. However, in general the practice to theory links between both journals were extremely low.

6. Discussion

There are several lessons from this seemingly aspirational exercise of trying to find references to ACI publications in MIM papers as practical underpinnings for theory and/or methodological development. The first is that the relatively short life of ACI (<6 years) may not be sufficient to realize the hope of the founding editors to see a direct link from papers on the practice of clinical informatics to theory-based papers published in MIM. This leads to the second lesson that it may not be possible to find such a link in all papers published in ACI due to the nature of the topic being discussed. It is also possible that the current ACI editorial policy that asks for ‘clinical relevance’ statements to be included in each paper directs the authors to consider only the significance of their work to the clinical realm.

Current editorial policies of ACI are to peer-review and accept manuscripts on any topic of relevance to clinical informaticians in operational roles, academics, government, and industry. ACI’s mission is to establish a platform that allows sharing of knowledge between clinical medicine and health IT specialists as well as to bridge gaps between visionary design and successful and pragmatic deployment. Topics of interest as stated on our website include clinical information systems, personal health records, physician/provider order entry, electronic prescribing, clinical decision support, nursing information systems, patient scheduling and tracking tools, lab information systems, radiology information systems, administrative and management systems, eHealth systems, information technology development, deployment, and evaluation, socio-technical aspects of information technology and health IT training.

As with any academic journal, we consider articles that are submitted to us (unsolicited) for regular or theme issues while keeping solicited manuscripts on specific topics of interest or editorials to a minimum. In this setting, there are several possible directions in which ACI editorial policy could evolve. Based on consensus from the editorial board, there is a possibility of encouraging and even fostering theme issues on topics of interests including a yearly or bi-annual issue on the specific topic of bridging informatics practice and theory. To supplement the ‘clinical relevance’ statement, it is conceivable that authors may be asked to consider adding a statement on “underlying informatics theory, if any” to their submissions and cite relevant journal articles to support this statement (MIM and other journals). The composition of the editorial board (of Editor-in-Chief and senior and associate editors) may also subtly influence submissions, peer review, and acceptance. The legacy policy of maintaining a diverse and international editorial board of clinical informaticians in various operations and research roles ensures a broad interest in clinical informatics and likely encourages high-quality submissions.

We acknowledge several limitations of this exercise. We did not perform a thorough systematic analysis of the reference lists in all MIM articles but we could observe that MIM authors very often cite medical/clinical journals when referring to a problem or clinical application area. An example of this was in 2014 when one of the focus themes dealt with bio-signal interpretation and there were numerous references to a clinical journal (Circulation).
In addition, the variety of topics in MIM is broad and several papers do not show any overlap with ACI topics. Looking for ACI and MIM cross-references in the calendar year 2014 may have limited our view as there may be a lag of several years before an MIM paper on informatics theory may have been informed by practice; thus the search was extended to all years. ACI papers may have cited informatics theory published in other journals. There were instances of ACI papers citing theoretical constructs in the methods applied.

7. Conclusions

The lack of direct links from informatics theory-based papers published in MIM in 2014 to papers published in ACI continues as was described for papers published during 2012 to 2013 in the two companion journals. Thus, there is little evidence that theory in MIM has been informed by practice in ACI. From its position as an official journal of IMIA, ACI has now matured and achieved recognition as an official journal of AMIA. This is expected to increase the number of submissions and may lead to links to articles in the Journal of the American Medical Informatics Association (JAMIA). These changes will likely lead to subtle shifts in editorial policies and acceptance of articles of broad interest to members of two large and influential international informatics organizations. For the successful practice of clinical informatics, the aspiration continues that there be direct links and bridging to informatics theories, established and evolving.

Acknowledgments

Formulating and fine-tuning the questions to be addressed, methods to be applied, nature and type of analysis, interpretation of the results, and general discussion on the topic of bridging informatics practice and theory was done by consensus by Adi V. Gundlapalli, Reinhold Haux, Christoph U. Lehmann, and Sabine Koch. The discussions and logistics were aided by technology to bridge these authors across two continents. Some statements in sections 6 and 7 have been influenced by discussions at the editorial board meetings of ACI and of MIM during Medinfo 2015. AVG is supported in part by U.S. Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, Health Services Research and Development Project #IIR 12-084.

The opinions expressed are those of the authors and do not necessarily reflect the opinions of the U.S. Government or the U.S. Department of Veterans Affairs.

CUL is the editor-in-chief and AVG is an associate editor of Applied Clinical Informatics. There are no other conflicts to declare.

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