



Methodological Review

Examining the role of collaboration in studies of health information technologies in biomedical informatics: A systematic review of 25 years of research

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ABSTRACT

Purpose: Our objective was to identify and examine studies of collaboration in relation to the use of health information technologies (HIT) in the biomedical informatics field.

Methods: We conducted a systematic literature review of articles through PubMed searches as well as reviewing a variety of individual journals and proceedings. Our search period was from 1990–2015. We identified 98 articles that met our inclusion criteria. We excluded articles that were not published in English, did not deal with technology, and did not focus primarily on individuals collaborating.

Results: We categorized the studies by technology type, user groups, study location, methodology, processes related to collaboration, and desired outcomes. We identified three major processes: workflow, communication, and information exchange and two outcomes: maintaining awareness and establishing common ground. Researchers most frequently studied collaboration within hospitals using qualitative methods.

Discussion: Based on our findings, we present the “collaboration space model”, which is a model to help researchers study collaboration and technology in healthcare. We also discuss issues related to collaboration and future research directions.

Conclusion: While collaboration is being increasingly recognized in the biomedical informatics community as essential to healthcare delivery, collaboration is often implicitly discussed or intertwined with other similar concepts. In order to evaluate how HIT affects collaboration and how we can build HIT to effectively support collaboration, we need more studies that explicitly focus on collaborative issues.

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1. Introduction

Collaboration is an essential part of the healthcare delivery system, but it is not often explicitly studied in research on health information technology (HIT). One challenge in studying collaboration is that it can be difficult to define. Based on the definition provided by Weir et al. [1] and for the purposes of this review, we define the collaboration as: *planned or spontaneous engagements that take place between individuals or teams of individuals, whether in-person or mediated by technology, where information is exchanged in some way (either explicitly, i.e. verbally or written, or implicitly, i.e. through shared understanding of gestures, emotions, etc.), and often*

occur across different roles (i.e. physician and nurse) to deliver patient care.

Collaboration is a difficult concept to study because it often includes aspects of other concepts, such as coordination [2], cooperation [3], and communication [4]. Although all four terms focus on how individuals interact with each other to provide care, the extent of the interaction is different in each of these terms. According to Fuks et al. [4], “communication is related to the exchange of messages and information among people; coordination is related to the management of people, their activities and resources; and cooperation is the production taking place on a shared workspace” (p. 637). These three terms are interrelated. For example, the 3C Collaboration model describes *communication* as the exchange of information to generate commitments that are then managed by *coordination* so that individual care activities interact through shared spaces to work *cooperatively* to ensure the success of the overall care process [4]. While communication,

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coordination, and cooperation often work together to comprise collaboration, each individually fails to encompass the type of engagement and shared understanding highlighted in the above definition of collaboration. At its core, collaboration involves the development and testing of rules of engagement and shared understanding that facilitates *how* people work together in shared spaces [5].

The increased prevalence of chronic illness and the recognition of the benefits of team-based healthcare delivery are drivers for increased collaboration. Although the need for increased collaboration in healthcare has been well described [6,7], how to implement successful collaboration is not as well understood. Studies have examined many aspects of collaboration including education [8,9], teamwork [10,11], patient-centeredness [12], technologies' impact on collaboration [13], and designing for collaboration [14]. While there has been a great deal of focus on appropriately integrating HIT within clinical workflows, collaboration is often only implicitly discussed as an aspect of individuals' activities [15]. Consequently, unintended consequences can occur because HIT is not properly aligned with underlying collaborative processes [16]. Therefore, we need to better understand how HIT is situated in settings that are highly collaborative.

Given the goal of increasing collaborative care delivery [6], we believe that this is the ideal time to look at the state of research about collaboration and HIT. Therefore, in this systematic review, we aim to better understand how collaboration in HIT research has been studied within the biomedical informatics community over the past 25 years. We have three specific goals for this paper. First, we want to analyze existing research to describe the state of knowledge in the biomedical informatics community on collaboration in relation to HIT. Second, we want to develop a model to help researchers who are interested in studying collaboration and HIT. Finally, we want to identify future research directions for the biomedical informatics community in studying collaboration and HIT.

2. Methods

2.1. Research questions

Overall, our objective was to better understand the role of collaboration in HIT research within the biomedical informatics community. Consequently, we had the following research questions: (1) What types of HIT are part of studies on collaboration? (2) What are the methods used in studies of these technologies? (3) What particular issues do studies that explicitly discuss collaboration focus on? Answering these questions will enable us to highlight what researchers have noted about collaboration and HIT in ways that would be useful to other researchers and practitioners.

2.2. Literature search strategy

To identify relevant papers, the first author (EE) first conducted an extensive search of PubMed from 1990 to 2015. As instructed by a librarian, we used the MeSH terms “Medical Informatics” or “Medical Informatics Computing” or “Medical Informatics Applications” in an attempt to obtain the most relevant results. EE searched the titles and abstracts using the keywords “collaboration” and “technology.” To narrow the number of results returned, EE used filters to ensure paper abstracts were in English and dealt with collaboration amongst individuals. The PubMed search yielded 258 total results, of which EE either downloaded or noted the citation for 76 papers.

In order to ensure no other potentially relevant papers were missed, EE also searched the Penn State University Libraries online.

Using the keywords “collaboration” and “technology” to search abstracts and with an advanced search, EE used medical and health informatics journals' names (using the list of journals from [17]) as the publication title. EE also used filters to ensure papers were in English and peer-reviewed.

Finally, EE used Google Scholar to search conference proceedings, specifically MedInfo (IMIA: the International Medical Informatics Association) and AMIA (the American Medical Informatics Association). Because of the limitations of Google Scholar, EE searched for the keywords “collaboration” and “technology” anywhere in the document. The search within proceedings of AMIA yielded 371 results, and MedInfo yielded 70 results. EE pulled up each paper and searched for the terms “collaboration” and “technology” within each document and then determined if it met the initial inclusion criteria. EE downloaded and/or noted the citation of 53 of the 371 AMIA articles and 14 of the 70 MedInfo articles.

We intentionally did not search for concepts similar or related to collaboration, such as coordination or cooperation because we were interested in how the biomedical informatics community specifically has studied collaboration in relation to HIT.

2.3. Study selection & characteristics

We pre-identified 10 articles that dealt with both collaboration and technology in the biomedical informatics community before conducting the searches. However, all of these documents used the terms collaboration and technology somewhere in the text. The first author (EE) conducted the literature search. Fig. 1 shows the process of identifying and reviewing papers. During the first part of our search process, EE focused on papers in biomedical informatics-related journals and conference proceedings. Articles from these venues had to have both the terms “collaboration” and “technology” (in the abstract or title for the PubMed search, in the abstract for the Penn State University Libraries journal search, and anywhere for the Google Scholar conference search). They also had to be in English (the abstract for the PubMed and Penn State University Libraries searches and the whole document for the Google Scholar conference search) and had to be peer-reviewed.

Based on these criteria, PubMed, Penn State University Libraries, and Google Scholar returned 943 total results. For the second phase of our process, EE reviewed each abstract of these articles. Articles were excluded if they did not focus on team-level collaboration among people. As a result, EE downloaded the PDF and/or citation of 214 articles plus the 10 articles we had pre-identified for a total of 224.

For the next phase, EE read each article and compiled an Excel sheet with the authors, title, year, and publication of those 224 potentially relevant articles. After removing duplicates, manuscripts not completely in English, and partial manuscripts, EE then went through each of the remaining 173 articles extracting technology type, co-located vs. dispersed collaborations, modality (asynchronous, synchronous), location (e.g. hospital), country/continent, methodology, and collaborators. Of those, 75 were not relevant to our topic and thus removed. EE then conducted a thematic analysis similar to [18] and supported by [19]. Going through the articles, EE began noticing themes related to collaboration, which we eventually termed processes and outcomes (workflow, communication, information exchange and awareness, common ground). Once these themes were identified, EE went through each article again to extract data related to these processes and outcomes. The themes emerged from the analysis of the papers and were inductively identified. EE also considered the use of the term collaboration and other similar terms.

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