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Mobile Health Information Technology and Patient Care: Methods, Themes, and Research Gaps

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Abstract: The focus of the healthcare industry on delivering Patient-Centered Care (PCC) using Mobile Health Information Technologies (MHIT) is rapidly increasing, yet this critical area is still under-researched in the IS/IT literature despite the fact that mobile devices and their applications are widely spread and are likely to change the way of using and applying healthcare services. In this study we further analyze the literature reviewed in Dadgar et al (2013) to uncover research gaps in the area of MHIT which needs further attention. This work posits a preliminary research agenda, in forms of gaps, which can help propel future work in the field of MHIT for patient centered care.

INTRODUCTION

This paper builds on the work of Dadgar et al. (2013) on mobile health IT. Dadgar et al. (2013) conducted an extensive review of the literature which provides a broad overview of research conducted in the area of mobile IT for patient care. In this paper, we extend that work by further analyzing the findings in the literature to highlight the research gaps in each of the emerging themes uncovered in Dadgar et al. (2013). White (2013) reports that Patient centered care (PCC) has gained significant momentum in recent years where the focus is shifting from productivity and efficiency to patient care driven outcomes. The new legislation such as the Affordable Care Act and the creation of Patient-Centered Outcome Research Institute could further drive PCC related efforts. Due to the consumerization of IT, Mobile Health IT (MHIT) has a potential for being a critical catalyst for delivering patient centered care. Chatterjee et al. (2009) and Dadgar et al. (2013) argue that, although MHIT is being introduced within the healthcare industry and its use could significantly transform patient care, the scholarship in this area is at its incipient stages and thus it has been under-researched. The main objective of this paper is to analyze and discuss issues and opportunities surrounding PCC enabled by Mobile Health IT, in both the IS and Healthcare fields, in efforts to develop a research agenda for future research. Therefore, in this paper we identify the research gaps within each of the key themes revealed in Dadgar et al (2013). The paper is organized as follows. First, the paper recaptures the literature review process used to conduct the study by Dadgar et al. (2013). Second, a discussion on the methods, emerging themes, and research gaps is provided. Third, a section is dedicated to the research contribution. Finally, the paper provides a brief concluding discussion.

METHODOLOGY

Figure 1 summarizes the literature review process conducted in Dadgar et al. (see Dadgar et al. (2013) for more details). Their literature search was conducted at the intersectionality of mobile, healthcare, and IT/IS (Figure 1). The search resulted in 133 articles from 29 different journals and 14 conferences. The papers were categorized into four areas which are illustrated in figure 1. The irrelevant papers (Area 1) that were removed from the list were about mobile devices and applications but not in the healthcare industry. The most relevant papers (Area 2) included mobile, healthcare as well as IT/IS context. After removing the irrelevant papers a total of 57 papers were reviewed. These papers also included the studies which were about healthcare IT (Area 3) and mobile healthcare papers (Area 4) which were both related to healthcare. Themes and findings from Dadgar et al. (2013) are re-presented in this paper with more discussions around patient care, methods, and research gaps necessary for conducting research on MHIT for PCC.
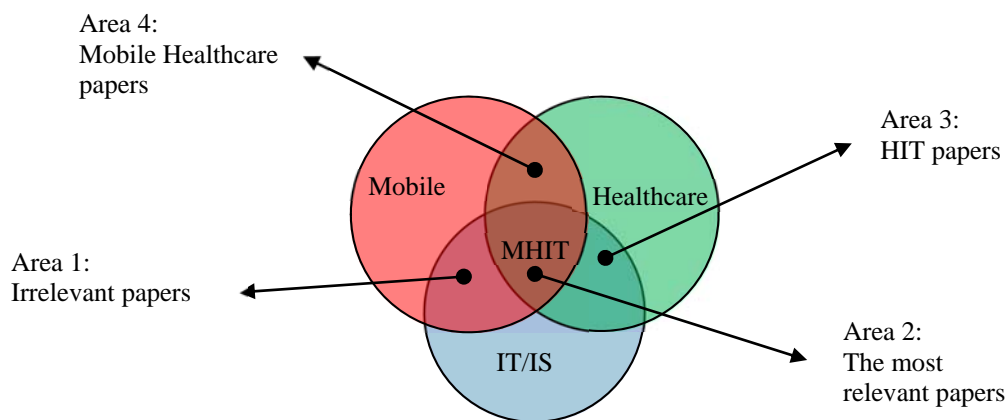
Figure 1: Initial literature review

The research gap analysis was bounded by the literature review conducted by Dadgar et al. (2013). The review looked into publications in major IT/IS and medicine journals and conferences (Figure 2). There is a possibility that other relevant papers were published in different journals or conferences were not captured in our search results. It is also evident that only few papers were found while searching the literature using the term "Patient Care". Furthermore, the term "Mobile" was defined differently in different papers and this caused the elimination of a number of papers that defined mobile out of the context of mobile health informatics.

Research Objective
- Review of the Literature on Mobile IT Patient Care
- To examine the extant literature to understand the role mobile information technologies play in providing patient

Boundaries/Limitations
- "Mobile" was defined differently within the papers.
- Including "Patient care" in the search, resulted in very few papers.
- Search was limited to the published papers in the major journals and conferences in IS/I healthcare.
- The papers up to 2012 were included in the
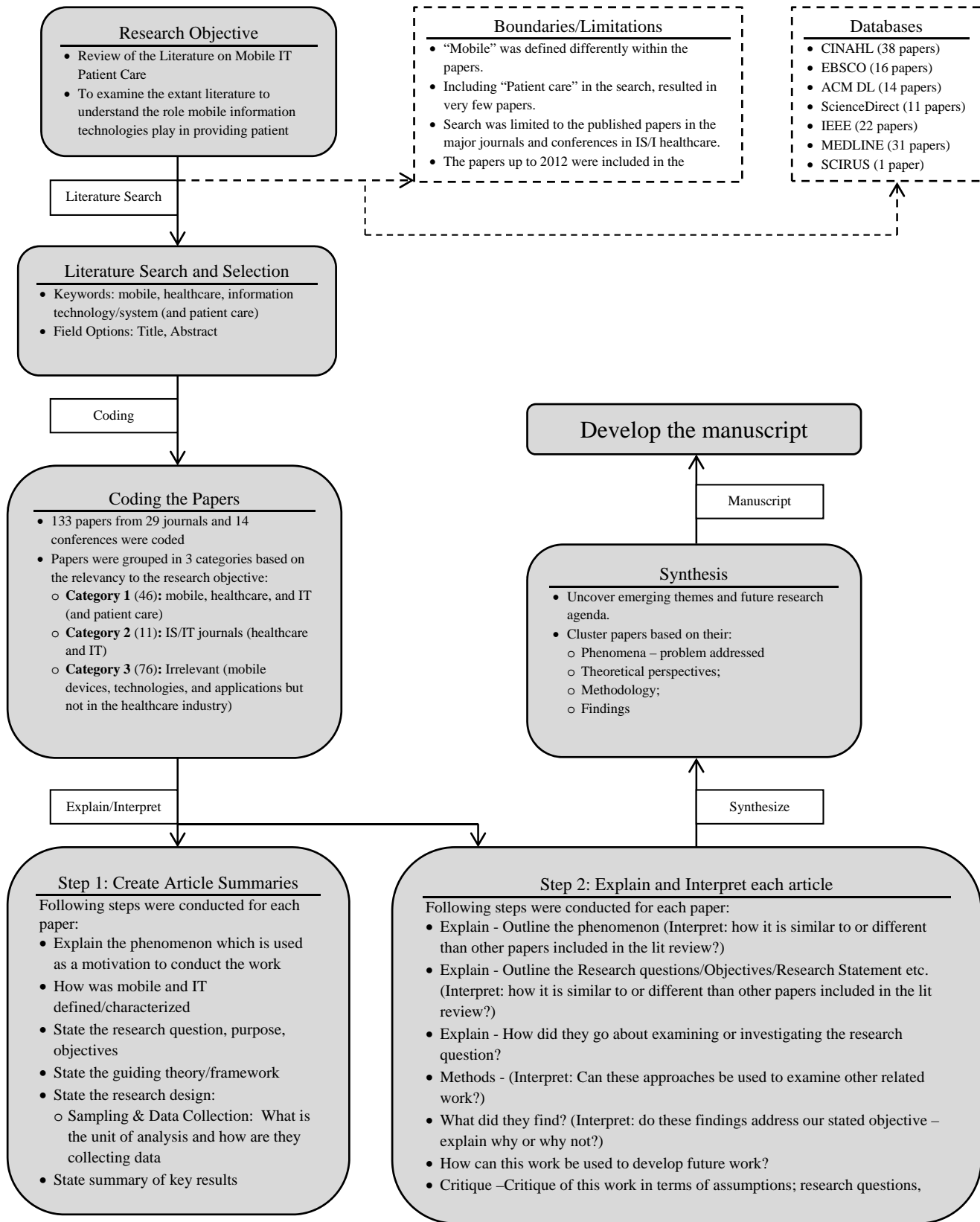
Databases
- CINAHL (38 papers)
- EBSCO (16 papers)
- ACM DL (14 papers)
- ScienceDirect (11 papers)
- IEEE (22 papers)
- MEDLINE (31 papers)
- SCIRUS (1 paper)

Literature Search

Literature Search and Selection
- Keywords: mobile, healthcare, information technology/system (and patient care)
- Field Options: Title, Abstract

Coding

Develop the manuscript

Manuscript

Coding the Papers
- 133 papers from 29 journals and 14 conferences were coded
- Papers were grouped in 3 categories based on the relevancy to the research objective:
  o **Category 1** (46)**:** mobile, healthcare, and IT (and patient care)
  o **Category 2** (11)**:** IS/IT journals (healthcare and IT)
  o **Category 3** (76)**:** Irrelevant (mobile devices, technologies, and applications but not in the healthcare industry)

Synthesis
- Uncover emerging themes and future research agenda.
- Cluster papers based on their:
  o Phenomena – problem addressed
  o Theoretical perspectives;
  o Methodology;
  o Findings

Explain/Interpret

Synthesize

Step 1: Create Article Summaries
Following steps were conducted for each paper:
- Explain the phenomenon which is used as a motivation to conduct the work
- How was mobile and IT defined/characterized
- State the research question, purpose, objectives
- State the guiding theory/framework
- State the research design:
  o Sampling & Data Collection: What is the unit of analysis and how are they collecting data
- State summary of key results

Step 2: Explain and Interpret each article
Following steps were conducted for each paper:
- Explain - Outline the phenomenon (Interpret: how it is similar to or different than other papers included in the lit review?)
- Explain - Outline the Research questions/Objectives/Research Statement etc. (Interpret: how it is similar to or different than other papers included in the lit review?)
- Explain - How did they go about examining or investigating the research question?
- Methods - (Interpret: Can these approaches be used to examine other related work?)
- What did they find? (Interpret: do these findings address our stated objective – explain why or why not?)
- How can this work be used to develop future work?
- Critique –Critique of this work in terms of assumptions; research questions,

Figure 2: Literature Review Process

KEY FINDINGS: DISCUSSION AND ANALYSIS

Methods

Table 1 describes the methods used in the MHIT literature. Nine different methods have been used across the nine themes discussed in this paper. The literature suggests that 32% of the papers have used conceptual methodologies and only 2% of the studies have used secondary/archival data (see Dadgar et al. 2013 for more details).

Method	Description
Design Science	Testing and evaluating systems and technologies using design principles
Secondary/Archival Data	Using archival data such as unreported publications, magazines, multimedia
Conceptual	Papers with no specific data collection
Field Experiment	Data collection and observational studies in the field
Mathematical Modeling	Using predictive and analytical modeling based mathematical equations
Survey/Questionnaire	Distributing hard/soft copies of surveys and questionnaires to the subjects
Qualitative Study	Case-based studies and interviews
Simulation	Computer simulations such as agent-based modeling
Multi Method	Using mix of qualitative and quantitative methods

Table 1: Description of the methods

Emerging Themes

The literature review and analysis on MHIT and patient care revealed nine emerging research themes (Dadgar et al., 2013). These nine emerging themes in the MHIT literature are presented in Table 2. These themes along with methods and research gaps within these themes are discussed in the following section.

Title	Description
Building and Using Healthcare Information Technologies and Systems for Patient Care (Build/Use HIT)	Literature on design, implementation, use, and/or adoption of IST in the healthcare industry.
Communication with Patients and Health Professionals (Communication Patient/Health)	Literature on wireless technologies that enhance communication among healthcare professionals, patients, and their relatives.
Healthcare Data and System Integration (Health Data/SI)	Literature on data and systems integration issues in healthcare.
Healthcare IT Success (HIT Success)	Literature on HIT success and failure factors.
Healthcare IT Value (HIT Value)	Literature on the benefits of HIT
Mobile Healthcare Delivery for Patients (M Health Delivery)	Literature on the issues of physical mobility of the healthcare units for the low-income neighborhoods or aging population in the rural areas.
Patient Monitoring	Literature on the issues related to monitoring of aging population or patients with chronic diseases.
Patient Work Flow	Literature on ways mobile technologies facilitate and optimize patient work flow.
Privacy/Security of Patient Data (Privacy/Security)	Literature on privacy of patient health data and the security of patient care systems and technologies.

Table 2: Emerging Themes (see Dadgar et al. (2013))

Methods, Themes, and Research Gaps

Table 3 summarizes the methods used and research gaps revealed within each theme. In this section we will further discuss methods and research gaps by themes. Unlike Dadgar et al. work where they summarized the literature by describing each study, in this paper we analyze each theme to uncover the research gaps that can help in outlining future directions for this nascent research field.

Themes	Papers	Method	Research Gap
Build/Use HIT	Ammenwerth et al. (2000) Barbash, A. (2001) Cocosila and Archer (2005) Hu et al. (1999) Kelley et al. (2011) Melander-Wikman et al. (2008) Moores, T. T. (2012) Raghupathi and Tan (2008) Siau and Shen (2006) Siddiqi et al. (2009) Wälivaara et al. (2011) Werner et al. (1995) Wu et al. (2011)	Design Science (1), Conceptual (5), Field Experiment (1), Mathematical Modeling (1), Survey/Questionnaire (1), Qualitative Study (2), Multi Method (2)	Limited research on the direct effects of HIT on patient care outcomes.
Privacy/Security	Xu et al. (2011) Rindfleisch, T. C. (1997) Mirkovic et al. (2001) Malhotra et al. (2008) Cannoy and Salam (2010) Avancha et al. (2012)	Design Science (2), Conceptual (1), Survey/Questionnaire (1), Multi Method (2)	Patient centric consequences of making patient records available on mobile devices need to be examined.
Communication Patient/Health	Campbell and Durigon (2003) Deverson et al. (2012) MacKay and Harding (2009) Mendonça et al. (2004) Sammon et al. (2007) Wilson, E. V. (2003)	Design Science (1), Mathematical Modeling (1), Survey/Questionnaire (1), Multi Method (3)	Need to bridge the gap between the Build/Use theme and the communication theme by looking more into how to facilitate the IT artifacts to support information flow and communication needs in the healthcare industry.
Patient Work Flow	Bharadwaj et al. (2001) Day et al. (2010) Sasaki et al. (1998)	Design Science (1), Conceptual (1), Simulation (1)	Need to examine mobile IT self-efficacy and its effects on intention of using mobile technologies by nurses and doctors and its effects on patient work flow
Health Data/SI	Grimson et al. (2000) Hashem and Ruggeri (2003)	Conceptual (2)	Data integration issues and their direct effects on patient centered care has received limited attention.
Patient Monitoring	Bae et al. (2012) Berke et al. (2011)	Design Science (2), Secondary/Archival Data	Optimal ways of balancing self-

	Blake, H. (2008) Fan et al. (2008) Mathews and Butler (2005) Pinnock et al. (2007) Ros et al. (2008) Sneha and Varshney(2009) Varshney, U. (2008) Varshney and Sneha (2006) Li et al. (2010)	(1), Conceptual (4), Field Experiment (1), Mathematical Modeling (1), Survey/Questionnaire (1), Qualitative Study (1)	management capabilities of patients using mobile technologies with face-to-face doctor visits and treatments need to be designed; long term consequences of remote monitoring of patients need to be studied.
HIT Success	Avison et al. (2007) Chatterjee et al (2009) Iacovou, C. L. (1999) Lerouge et al. (2007)	Mathematical Modeling (1), Qualitative Study (2), Multi Method (1)	More research needed to provide key factors of technology success in the healthcare industry and highlight the direct impact of the success on patient care outcomes.
M Health Delivery	Mayernik et al. (2010) Muolavie et al. (2000) Neill and Powell (2009)	Conceptual (1), Field Experiment (1), Survey/Questionnaire (1)	More work is needed in exploring the design and delivery of care using mobile vehicles especially for the underserved communities such as patients in the rural areas or low-income neighborhoods.
HIT Value	Chen et al. (2009) Kane and Alavi (2008) Kaplan, W. (2006) Menon et al. (2000) Michelman and Kim (1990) Paré et al. (2011) Payton et al. (2011) Trobec and Stanic (2011) Varshney, U (2005)	Design Science (1), Conceptual (4), Survey/Questionnaire (1),	**More research is needed to highlight the actual value mobility adds to the current technology and how does that impact on patient care delivery**

Table 3: Themes by papers, methods, and research gaps

Build/Use HIT

This theme includes the literature that discussed the design, development, implementation, use, and/or adoption of ISTs in the healthcare area. Our analysis of Dadgar et al. (2013) MHIT review reveals that the research conducted under this theme uses a range of methodologies such as, design science, conceptual, field experiment, mathematical modeling, survey/questioners, qualitative study and/or multi method, to examine technological, design, and behavioral issues germane to the use of IT in delivering patient care. Literature review suggests that compared to other themes this theme is relatively well researched and included the largest number of papers as reported by Dadgar et al. (2013). The research in this area had focused on technology involvement in healthcare delivery but the research on the direct effects of HIT on patients is limited. No evident research was conducted to investigate the impact of healthcare technologies on patient care outcomes, such as, mortality level.

Privacy/Security of Patient Data

Papers under this theme discuss the issues involved in the privacy of patient data and the security of the systems and technologies that support patient health data. The literature included under this theme mainly examines the technical challenges of transitioning from paper-based patient records to digital records. Design science, conceptual, survey/questionnaire, multi method methods have been used to address the technology-centric security issues surrounding the digitization of patient records. Our analysis of Dadgar et al. (2013) reveals that there is a need to extend current knowledge in this area to mobile devices and technologies. We suggest that researchers study the transition from digital records to digital records on mobile devices. We believe that multi methods techniques can best address the research problems under this theme. In-depth qualitative interviews will allow researchers to uncover rich insights on patients' values, preferences, and needs regarding the accessibility of medical records on mobile devices. Design science methods can also be used to integrate privacy concerns of the patients into the design and implementation of secure mobile technologies and systems supporting patient records.

Communication with Patients and Health Professionals

Papers under this theme looked at improving the flow of information and communication within the healthcare industry. The communication was conceptualized differently within each paper, for instance, some looked at it as a behavioral interaction among the stakeholders, or as the challenges disabled patients face when trying to communicate; other papers listed the advantages and disadvantages of using different mobile devices in healthcare facilities. A range of methods, such as design science, mathematical modeling, survey/questioner or multi method, were used to examine the communication and information flow issues emerging during the conduct of patient care. Our analysis of Dadgar et al. reveals that more research needs to be directed to address how the knowledge discovered in this area regarding the accessibility and free flow of information, communication, and education to empower patients can be used to by researchers to design and implement mobile applications.

Patient Work Flow

Papers under this theme examine how mobile technologies can facilitate and optimize patient work flow for treatments and quality of care. Studies in this theme are mindful of the consequences of using mobile technologies to enable patient work flow. For example, research show that using mobile devices physicians can make treatment decisions for the patients in a shorter amount of time (e.g., Bharadwaj et al. (2001)). Mobile technologies can also help to resolve the conflict between treatments and medical policies. All these benefits provide more efficient ways of delivering better quality of care to the patients. Design science, conceptual, and simulation methods have been used in the papers under this theme. We suggest the use of simulation techniques, such as agent-based modeling, for conducting future studies related to this theme. Researchers can simulate the use of mobile technologies to examine its effects on patient work flow. The nature of patient work flow and medical staff work flow can be simulated to first uncover the incongruities among these workflows and then to examine the effects of these incongruities on the quality of care. An underlying assumption in the literature found under this theme is that nurses and doctors use portable devices at work to provide better quality of care for their patients. We suggest that researchers verify this assumption in future studies. For instance, future studies should study the effects of using mobile technologies by nurses and doctors on patient work flow to explore whether the use of mobile technologies disrupts or facilitates patient care related workflow.

Health Data and System Integration

Papers under this theme have focused on the effects of promoting integration-friendly infrastructure on MHIT in terms of use, cost and scalability. None of the papers included in this theme directly addressed the issue of patient care; rather they reported the effects of integral infrastructure on the use of MHIT and explored the advantages of system integration in the healthcare industry. Dadgar et al. (2013) mention that very few studies have focused on the role of data and system integration within the context of healthcare, and no method, other than the conceptual research, was

found. We call on IS researchers to focus on data integration issues and their direct effects on patient centered care, as there is a significant dearth of research in this area.

Patient Monitoring

The papers under this theme study the issues around providing remote patient monitoring services mostly for the aging population or for the patients with chronic diseases. Design science, secondary/archival data, conceptual, field experiment, mathematical modeling, survey/questionnaire, qualitative study methods have been used to study this area. Considerable number of conceptual papers were found in the literature under this theme. Although these studies examine the operationalizability of the mobile technologies such as mobile sensors or wearable healthcare monitoring systems to collect data from patients, they did not study whether or not these approaches satisfy patients' values, preferences, and needs. There are several benefits afforded by mobile patient monitoring such as instant and constant control on the patient health conditions. We suggest that the future work should design optimal ways of balancing remote and on-site care, but also study the extent the combination of face-to-face visits and remote monitoring improve the quality of patient care. Researchers should also study the long term consequences of remote monitoring on patients. In addition, the designs of these services should be guided by patients' values and preferences.

HIT Success

Some papers under this theme have reported key factors that shape HIT failure while other papers have posited theoretical models that provide a consolidated view of the literature in the area of mobile work in healthcare. Papers under this theme used mathematical modeling, qualitative study or multi method while examining the factors related to the success and/or failure of HIT. Dadgar et al. (2013) found that only few papers were included under this theme and these papers have focused on all 3 components (Mobile, IT, and Healthcare). HIT success and failure research is directly related to patient centered care. Although the theme had the fewest number of papers, yet they all addressed the research gap referred to in this paper. Scholars are encouraged to provide factors that have direct impact on technology success when used by healthcare providers highlighting the relation between HIT success and patient care outcomes.

Mobile Health Delivery

Papers under this theme discuss the challenges of bringing mobile health services physically to the rural or low-income neighborhoods or to the elderly at their residences. Although the papers under this theme did not discuss the use of IT in detail but the combination of physical mobile vehicles and mobile technologies can be an interesting area of future research. Conceptual, field experiment, and survey/questionnaire methods have been used in the papers under this theme. Studies in this theme do not discuss the mobile technologies which can potentially be embedded in the physical mobile vehicles. The papers under this theme are mostly constrained to the physicality of mobile vehicles and medical services. We argue that IT-enabled mobile vehicles could better serve patients in the rural areas or low-income neighborhoods and could provide higher quality of care for the patients. We suggest that researchers should study how mobile technologies can affect design of the mobile vehicles or units while saving cost and time.

HIT Value

Research under this theme focused on assessing the value of HIT and MHIT. The key research findings in this theme suggest that current technology has significant impact on patient care and that IT can help both healthcare providers and patients themselves who wants to take more control over their health. From Dadgar et al. (2013) review we found that the methods used under this theme were: conceptual, design science, survey/questioner, simulation, and/or multi methods. Papers under this theme focused mostly on the effects of technology on the benefits generated by healthcare providers. Although the research in this theme is closely related to the patient centered MHIT, wireless and mobile devices value on health organizations has limited research in the context of MHIT. More research is needed to highlight the actual value mobility adds to the current technology and how does that impact on patient care delivery.

CONTRIBUTION

The findings of this paper show that relatively little attention has been paid to understand the direct role of MHIT on patience centered care. In other words, the use of mobile technologies to examine outcomes proximal to patients' quality of care, values, preferences, and expectations need more attention. The nine themes uncovered in Dadgar et al. (2013) were further analyzed to find research gaps within each theme. We argue that limited, especially empirical research in this area creates interesting opportunities to conduct interdisciplinary research. This paper provides a preliminary research agenda which can help propel future work in the field of MHIT for patient centered care. Although in its initial stages, the research agenda revealed in this work in forms of gaps can fuel research at the intersectionality of mobile, healthcare, and IT to describe, predict, and prescribe the role of MHIT in patient centered care.
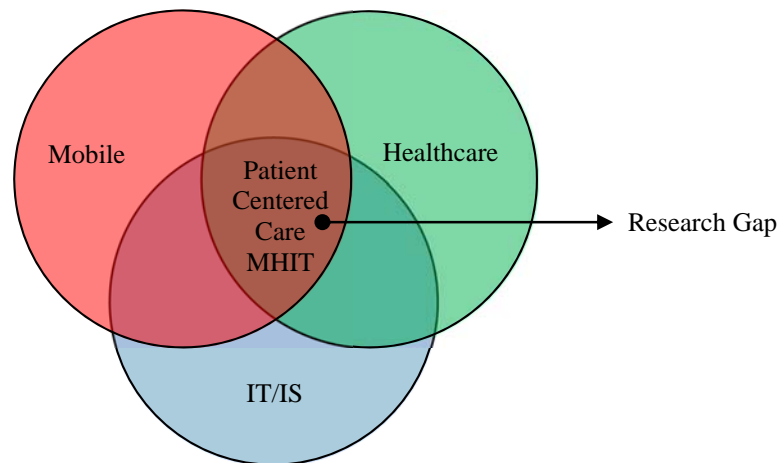

Figure 3: MHIT research gap area in the extant literature

CONCLUDING DISCUSSION

The analyses of the nine themes reveal that the research in the area of MHIT which centers on patient care is in its incipient stages. The limited work done to examine this phenomenon, as mentioned by Poon et al. (2006), could be because the "Adoption of HIT is limited and will likely remain slow unless significant financial resources are made available." Other reasons for the slow growth of research in this area include the complexity of the healthcare process, the high cost of implementation, the limited availability of time to build the technology, the need for developing open standards, and the management of security and privacy. The dearth of patient centered research at the intersection of mobile, healthcare and IT, (see Figure 3), creates interesting opportunities to conduct interdisciplinary research and we hope this would encourage scholars to conduct research in this area to address the research gaps discussed in this paper.

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