Understanding Care Coordination Activities Performed for Chronically Ill Patients

By

Sarah Kianfar

A dissertation submitted in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

(Industrial and Systems Engineering)

at the

UNIVERSITY OF WISCONSIN-MADISON

2016

Date of final oral examination: 12/17/2015

The dissertation is approved by the following members of the Final Oral Committee:

Pascale Carayon, Professor, Industrial and Systems Engineering

Robert Radwin, Professor, Industrial and Systems Engineering

Douglas Wiegmann, Professor, Industrial and Systems Engineering

Maureen Smith, Professor, Population Health Sciences

Mary Sesto, Associate Professor, Industrial and Systems Engineering

Dedication

I dedicate this dissertation to my parents, Roxana and Farhad, my husband, Amirali, and my brother, Dana, for your endless love, support and encouragement.

Acknowledgement

I would like to thank my PhD advisor, Professor Pascale Carayon, who has supported me over the past four years and a half. Without her help this dissertation would not have been possible. I would also like to thank all my committee members, Professors Robert Radwin, Douglas Wiegmann, Maureen Smith and Mary Sesto for their valuable insights and suggestions. I would like to acknowledge my colleagues at the Center for Quality and Productivity Improvement who helped me throughout my PhD program.

I would like to thank my family and friends who have supported me throughout my graduate studies. Special thanks to my partner in crime, Yaqiong, for always being there for me, and to my writing buddies, Autumn and Yvonne, for making sure I stayed focused on my dissertation.

I am thankful of all care managers and other healthcare professionals who participated in this research. I am also grateful for the funding by the US Office of the National Coordinator through the Beacon award program [award No. 90BC001301], and the CTSA program, previously through the NCRR Grant # 1UL1RR025011, and now by the NCATS Grant # 9U54TR000021.

Sarah Kianfar

Madison, WI

Abstract

Care coordination is important for chronically ill patients who need assistance from a variety of healthcare professionals especially when they transition through different care settings. This research includes two studies designed to understand care coordination for chronically ill patients. The first study characterizes care coordination activities (i.e., communication and monitoring) and their interdependencies (i.e., flow, shared resources and simultaneity). We conducted qualitative content analysis of 12 semi-structured interviews with healthcare professionals involved in coordinating care of chronically ill patients with CHF and COPD. We identified a total of 258 care coordination activities and developed three categories and eleven sub-categories for care coordination activities using the constant comparative method. 1) Communication with flow or shared resources interdependencies or both: arranging services and equipment for patient, exchanging information about patient transition to different care settings, reporting errors and resolving them, and helping patient with appointments and transportation. 2) Monitoring and Monitoring and communication with flow or shared resources interdependencies or both: reviewing medications and services and detecting errors, reviewing patient symptoms and following up if needed, and scheduling follow-up to review patient status. 3) Communication with simultaneity interdependency: talking in the same location and developing a plan of care, different people exchanging information at the same time, and scheduling delivery of medications/services at time of patient arrival home. Future research should include the perspective of patients about care coordination activities.

The second study focuses on communication during care transitions, which was identified as a key care coordination activity in the first study. Using secondary analysis of 60 interviews with healthcare professionals, we identified a total of 93 communication events in which healthcare professionals notify each other about four stages of patient transition: admission, discharge, transfer and emergency department visit. The most frequent communication media used by healthcare professionals for care transition notification are phone, care management software, and face-to-face communication. The choice of media depends on the content, purpose and urgency of the communication. For example, phone is used to provide additional information about the patient. Findings from this study can be used to develop health IT design requirements to support communication and coordination between care team members.

Table of contents

Chapter 1: Introduction

1.1 Background

Chronically ill patients constitute about half of the US adult population (Ward et al., 2014) and represent more than 80% of healthcare costs (Anderson, 2010). Chronic illnesses are among the major causes of death in the US (Murphy et al., 2013) . Congestive Heart Failure (CHF) and Chronic Obstructive Pulmonary Disease (COPD) are two common chronic illnesses. CHF is the most common cause of hospitalization among the elderly in the US (Coffey et al., 2012; Hollenberg & Heitner, 2012; Takeda et al., 2012). About 10% of people aged 80-89 (Takeda et al., 2012) and 2.5% of US adult population (Hollenberg & Heitner, 2012) have CHF. COPD is the "fourth leading cause of morbidity and mortality in the US" (Pauwels et al., 2001, p. 1257), and 11% of the US adult population have COPD (Edelman et al., 1992).

Chronically ill patients need assistance from a variety of care professionals to manage their condition (Bodenheimer, 2008). These patients often transition through different care settings such as hospital (admission or discharge), physician office and nursing home (Bodenheimer, 2008). Unsafe transitions put chronically ill patients at risk of re-hospitalization or even death (Jencks, Williams, & Coleman, 2009). Risks of re-hospitalization and death can be reduced by improving care coordination (Jencks et al., 2009). Care coordination is, therefore, of great importance for chronically ill patients.

Healthcare professionals involved in care coordination of chronically ill patients work across organizational, geographical and temporal boundaries (Carayon, 2006; McDonald et al., 2007). These boundaries create challenges for care coordination, such as insufficient discharge instructions, lack of information exchange between different care settings, and lack of follow-up care (Bodenheimer, 2008; Fagnan et al., 2011; Schoen et al., 2011).

Different interventions have been implemented to improve care coordination for chronically ill patients; these interventions have the potential to improve healthcare delivery and patient outcomes such as hospitalization and mortality rates (McDonald et al., 2007). However, there is limited evidence about their impact on patient outcomes. More information is needed about the care coordination activities that contribute to improving patient outcomes. It is important to further understand care coordination and associated activities for CHF and COPD patients. This research aims to identify and characterize care coordination activities for this patient population.

1.2 Research Questions

This research addresses the following research questions.

1) What care coordination activities do healthcare professionals involved in the care of chronically ill patients perform?

2) How do healthcare professionals involved in the care of chronically ill patients communicate to coordinate patient care?

1.3 Structure of the Dissertation

The remainder of this dissertation is organized as follows. Chapter 2 includes a review of the literature on chronically ill patients, including those with CHF and COPD and their need for care coordination. Then, challenges associated with care coordination of chronically ill patients and interventions used to tackle these challenges are reviewed. Chapter 2 also describes definitions of coordination and coordination activities, and explains how these definitions apply to the patient population of this study. Chapter 3 presents two research questions and associated conceptual frameworks. Chapter 4 explains the methods used to address the research questions. Results for both research questions are presented in chapter 5 and chapter 6 includes discussion and conclusion. Detailed results for the two research questions can be found in Appendices 9 and 10.

Chapter 2: Literature Review

2.1 Chronically ill patients

Chronically ill patients constitute about half of the US adult population (Ward et al., 2014) and represent more than 80% of healthcare costs (Anderson, 2010). Chronic illnesses are among the major causes of death in the US (Murphy et al., 2013). Congestive Heart Failure (CHF) and Chronic Obstructive Pulmonary Disease (COPD) are two common chronic illnesses. CHF is the most common cause of hospitalization among the elderly in the US (Coffey et al., 2012; Hollenberg & Heitner, 2012; Takeda et al., 2012). About 10% of people aged 80-89 (Takeda et al., 2012) and 2.5% of US adult population (Hollenberg & Heitner, 2012) have CHF. COPD is the "fourth leading cause of morbidity and mortality in the US" (Pauwels et al., 2001, p. 1257), and 11% of the US adult population have COPD (Edelman et al., 1992).

Chronically ill patients need assistance from a variety of care professionals to manage their condition (Bodenheimer, 2008). These patients often transition through different care settings such as hospital (admission or discharge), physician office and nursing home (Bodenheimer, 2008). Unsafe transitions put chronically ill patients at risk of re-hospitalization or even death (Jencks et al., 2009). Jencks et al. (2009) defined re-hospitalization rate as the "number of patients who were discharged from an acute care hospital and readmitted to any acute care hospital within 30 days divided by the total number of people who were discharged alive from the acute care hospital" (p. 1419). According to the study by Jencks et al. (2009), about 63% of the Medicare patients were re-hospitalized or dead within a year of hospital discharge and about 23% of the Medicare patients were re-hospitalized within 30 days of hospital discharge. Among

patients who were re-hospitalized within 30 days of discharge, those with CHF had the highest rate (27%) of 30-day re-hospitalization (Jencks et al., 2009). Patients with COPD had the third highest rate (23%) of 30-day re-hospitalization (Jencks et al., 2009). Risks of re-hospitalization and death can be reduced by improving care coordination (Jencks et al., 2009). Care coordination is, therefore, of great importance for chronically ill patients.

Care coordination interventions have the potential to improve patient outcomes (e.g., reducing re-hospitalizations and preventing deaths) for chronically ill patients (McDonald et al., 2007). Care coordination interventions such as care management have been shown to improve CHF patient outcomes including reductions in re-hospitalization and death (McDonald et al., 2007; Takeda et al., 2012). There is limited evidence for the impact of care coordination interventions for COPD patients (McDonald et al., 2007). The next section reviews challenges associated with care coordination of chronically ill patients and the different interventions used to tackle the challenges.

2.2 Care coordination challenges and interventions

2.2.1 Care coordination challenges

Chronically ill patients need assistance from a number of healthcare professionals (Bodenheimer, 2008). Pham et al. (2009) used Medicare claims data for patients treated in 2005 by 2,284 primary care physicians who responded to the Community Tracking Study (CTS) physician survey between 2004 to 2005. CTS was a longitudinal study with physicians in 60 nationally

representative communities in the US. The results of Pham et al. (2009) study showed that on average a primary care physician contacted 99 physicians in 53 practices to coordinate care for 100 Medicare patients. Healthcare professionals involved in care of chronically ill patients work across organizational, geographical and temporal boundaries (Carayon, 2006; McDonald et al., 2007). These boundaries create challenges for care coordination, such as insufficient discharge instructions, lack of information exchange between different care settings, and lack of follow-up care (Bodenheimer, 2008; Fagnan et al., 2011; Schoen et al., 2011).

Schoen et al. (2011) surveyed patients with complex healthcare needs in 11 countries, including the US, to learn about their experience of care coordination and patient safety. Patients aged 18 or older were selected if they met at least one of these criteria: 1) self-reported their health as fair or poor, 2) had chronic illnesses, 3) had serious injuries or disabilities in the past year, and 4) had surgery or were hospitalized in the past 2 years (Schoen et al., 2011). Final samples in the 11 countries ranged from 750 to 4808 patients. Areas for improvement in care coordination were identified in all countries. The authors found that lack of communication and information sharing between healthcare professionals in different care settings (e.g. primary care physicians and specialists) can lead to care coordination and safety issues, such as duplicate testing and medical errors. Transition of care problems were reported by 29% of patients in the US sample, and included insufficient discharge instructions and lack of follow-up care after being discharged from the hospital. Based on the findings of this study, interventions to improve coordination for chronically ill patients should focus on improving communication between the patient and the healthcare team, and providing appropriate follow-up care and resources when patients transition through different care settings.

Osborn et al. (2014) conducted computer-assisted telephone interviews with older adults in the same 11 countries as Schoen et al. (2011); the objective of this follow-up study was to learn about patients' experience with care coordination, access to care and patient centeredness. Osborn et al. (2014) focused on adults aged 55 or older. Final samples ranged from 379 to 5,000 people across the 11 countries. The majority of the participants had at least one chronic condition. Participants from the US had the highest rate of chronic conditions: 87% had at least one chronic condition and 68% had two or more chronic conditions. Participants from all countries had challenges with care coordination, including information exchange and discharge planning. Twenty three percent of US participants indicated that their medical information including test results were not available during their appointments or that tests were duplicated. Participants from all countries (19% of US participants) mentioned communication problems between primary care physicians and specialists. Sixteen percent of US participants indicated that they received conflicting information from different physicians. Participants from all countries (28% of US participants) reported discharge planning problems, such as not receiving a discharge plan, not having a follow-up appointment arranged, not being given instructions for taking medications and not knowing who to contact when they had questions. Similar to the Schoen et al. (2011) study, findings from Osborn et al. (2014) study suggest that care coordination improvements should focus on communication between different healthcare professionals and patients and on providing follow-up care after hospital discharge.

Fagnan et al. (2011) conducted a study to assess perceptions of healthcare professionals about managing care of chronically ill patients. The authors interviewed four groups of healthcare

professionals in six rural primary care clinics: 6 physician champions[1], 22 clinicians (physicians, physician assistants and nurse practitioners), 11 care managers and 6 administrators; questions were about perceived barriers to chronic illness management. All four groups of interviewees perceived inability of patients to self manage their care, lack of resources such as transportation and insurance and insufficient health literacy as challenges to chronic illness management (Fagnan et al., 2011). The interviewees also reported lack of an alert system for patient monitoring and follow-up as a challenge to chronic illness management. Another challenge in managing care of chronically ill patients was the need to communicate with a large number of healthcare providers (Fagnan et al., 2011).

Brennan et al. (2015) discussed findings from the eighth annual American Medical Informatics Association (AMIA)'s Health Policy Invitational Meeting in 2013, which emphasized the importance of information access and communication between healthcare professionals and patients. Healthcare professionals often do not have access to the same information due to the existence of institution-specific EHRs and lack of interoperability between the different information systems (Brennan et al., 2015; Carayon et al., 2012). Health IT should enable healthcare professionals across different care settings to have a longitudinal view of patient information and communicate with each other (Brennan et al., 2015). Designing health IT to support information access and communication by a multidisciplinary team is essential for coordinating care of chronically ill patients (Moran et al., 1994). Practices, such as improving information transfer during care transition, effective communication between healthcare

[1] "A physician who provided the initial contact to bring the study into the clinic and provided overall advice and guidance in its implementation" (Fagnan et al., 2011, p. 306).

professionals and patients/families and managing communication between specialty and primary care, should be incorporated in care coordination programs for chronically ill patients (Bayliss et al., 2014).

2.2.2 Care coordination interventions

Different interventions have been implemented to improve care coordination for chronically ill patients. McDonald et al. (2007) conducted a systematic review of care coordination interventions and their impact on quality of care. They identified three types of care coordination intervention: multidisciplinary teams, disease management and case management. A multidisciplinary team refers to "individuals from different disciplines who contribute specialized knowledge in non-hierarchical relationships and who act according to situational demands rather than traditional organizational roles" (McDonald et al., 2007, p. 42). Disease management interventions are "a system of coordinated healthcare interventions and communications for populations with conditions in which patient self-care efforts are significant" (McDonald et al., 2007, p. 43). Case management interventions include a case manager who monitors high-risk patients and arranges appropriate resources for them to improve their health. McDonald et al. (2007) concluded that care coordination interventions in general have a positive impact on patient outcomes, such as mortality, hospitalizations and re-hospitalizations. Multidisciplinary teams and disease management interventions were found to reduce hospital admission for CHF patients.

Communicating with patients and involving them in their chronic illness management can help address complications in a timely and effective manner and, therefore, improve patient outcomes (Schoen et al., 2011). Patient-centered medical home (PCMH) is an intervention aimed at improving communication between patients and the healthcare team, involving patients in their care, providing them with timely access to care and community resources, and arranging follow-up care (Crabtree et al., 2010; Scholle, 2010; Vest et al., 2010). PCMH has been successful in improving patient outcomes (e.g. hospitalizations, re-hospitalizations) in some studies (Gilfillan et al., 2010; Rosenberg et al., 2012), but other studies have identified challenges in the implementation of PCMH such as health IT support for communication and decision making (Crabtree et al., 2010; Nutting et al., 2011).

Brown et al. (2012) studied eleven care coordination programs that targeted high-risk patients, including those with CHF and COPD. These programs lasted six years and were part of the Medicare Coordinated Care Demonstration project. They involved care coordinators who performed activities, such as patient assessment, patient education, patient monitoring, and improving communication between patients and providers. The purpose of the study was to evaluate improvements in outcomes for high-risk patients and to identify characteristics of the programs that contributed to the improvements. Findings showed that, in four of the 11 programs, hospitalization rates were reduced by 8%-33%; there were no effects on hospitalization rates for the other seven programs. The four successful programs shared several common characteristics:

- In-person interaction of care coordinators with patients and their physicians
- Care coordinators being a “communication hub” for providers

- Patient education and medication management
- Transitional care management after discharge.

Hansen et al. (2011) conducted a systematic review of interventions aimed at reducing re-hospitalization within 30 days of discharge for different types of patients, including those with chronic illnesses such as CHF and COPD. They identified twelve types of interventions from the literature and categorized them in three groups: 1) pre-discharge interventions, 2) post-discharge interventions and 3) bridging interventions. Pre-discharge interventions included patient education, discharge planning, medication review and scheduling of follow-up appointment. Post-discharge interventions included follow-up phone calls, patient-activated "hotlines", home visits, timely outpatient follow-up and timely transfer of patient information to outpatient provider. Bridging interventions ensured a continuous relationship with patients before and after the discharge and emphasized the role of patients and caregivers in the transition from hospital to outpatient setting. Bridging interventions included patient-centered discharge instructions (customized to patient's literacy and social level), a transition coach (a nurse performing patient education and assessing social needs of patient before discharge), follow-up with patient and monitoring of patient symptoms and medications, and having the same provider for inpatient and outpatient care. Hansen et al. (2011) did not find a single or a combination of interventions that reliably reduced re-hospitalization within 30 days of discharge, but they believed there is potential for some of the interventions. For example, they described patient-centered discharge instructions and post-discharge telephone calls as an effective combination of post-discharge interventions, and having a transition coach as an effective bridging intervention.

Leppin et al. (2014) conducted a systematic review of discharge interventions and their impact on reducing 30-day hospital readmissions. They reviewed studies published in English or Spanish from 1990 to 2013. They used the taxonomy of discharge interventions by Hansen et al. (2011). The discharge interventions studied included discharge planning, case management, telephone follow-up, telemonitoring, home visits, scheduling follow-up appointment and other interventions. The authors concluded that their tested interventions were effective in reducing hospital readmissions.

Bates (2015) discussed the role of health IT in care coordination interventions. Health IT can improve communication between different people involved in patient care across different care settings. Health IT can offer different media of communication, such as free text, structured text and videoconferencing. Other areas in which health IT can contribute to care coordination include medication review, tracking lab tests and managing patient referrals. Rudin and Bates (2014) developed a framework for improving care coordination using health IT. This framework focuses on coordination activities performed by healthcare providers and identifies areas where health IT can help. The framework categorizes care coordination activities performed by providers in four groups: (1) identifying collaborators, (2) contacting collaborators, (3) collaborating and (4) monitoring.

Care management is an intervention that has been used for CHF and COPD patients (Brown et al., 2012; Steele et al., 2010). Care management involves care managers who follow patients through different care settings and ensure patients' conditions are managed and their symptoms

are under control (Steele et al., 2010). Care managers communicate and interact with patients and healthcare professionals to coordinate patient care. Care managers may be located in the hospital and provide disease education, perform medication review and prepare discharge instructions (Carayon, Hundt, et al., 2015; Oliva, 2010). The goal of these activities is to ensure patient transition to the outpatient setting goes well. Care managers can also be in the outpatient setting (e.g. clinics) and monitor patient symptoms, make follow-up phone calls, develop a relationship with patients and arrange services for patients when needed (Carayon, Hundt, et al., 2015; Maliski, Clerkin, & Litwin, 2004; Oliva, 2010). Care managers usually have access to patient information through health IT (Gilfillan et al., 2010). Although there is some evidence of care management improving hospitalization and mortality for CHF patients, it is not clear which activities contribute to these improvements (Takeda et al., 2012). There is limited research on the effectiveness of care management interventions for COPD patients (Fan et al., 2012).

In a previous study (Carayon, Hundt, et al., 2015), we conducted focus groups and interviews with 12 care managers (6 inpatient, 6 outpatient) who coordinated care for patients with CHF or COPD and surgical patients. The objective of the study was to identify activities that care managers believed contributed to patient and clinician outcomes. Inpatient care managers identified ensuring primary care follow-up, coordinating services for patients, providing patient education and ensuring accurate medication reconciliation as activities they perceived as having the most impact on patient outcomes. Outpatient care managers perceived teaching patients signs and symptoms of exacerbations and building effective relationships with patients as activities having the most impact on patient outcomes. All care managers believed that the support they provide to clinicians had the most impact on clinician satisfaction.

The various interventions described in this section were intended to improve care coordination for chronically ill patients. These interventions may result in improvements in care coordination and patient outcomes. However, it is not clear what aspects of the interventions contribute to the improvements. Therefore, there is a need for a deeper understanding of care coordination and build on the small number of studies that have begun to describe care coordination activities.

2.3 Care coordination

In the systematic review on care coordination discussed in section 2.2.2, McDonald et al. (2007) identified 48 different definitions of care coordination and coordination in the literature and synthesized them. The resulting definition of care coordination is: "the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services. Organizing care involved the marshaling of personnel and other resources needed to carry out all required patient care activities, and is often managed by the exchange of information among participants responsible for different aspects of care" (McDonald et al., 2007, p. 41). This research uses the definition of care coordination by McDonald et al. (2007).

2.3.1 Elements of care coordination

McDonald et al. (2007) identified five key elements of care coordination from their synthesis of the literature.

1) Various people participate in patient care: e.g., patient, physician, nurse, social worker, therapist and pharmacist.

2) These participants have different expertise and depend on each other to provide comprehensive patient care.

3) Participants need to have knowledge of resources available for patient care. They also need to have knowledge of each other's skills, roles, relationships, preferences and interdependencies between their activities to effectively coordinate patient care across organizational, professional and geographical boundaries.

4) Participants need to exchange patient information to coordinate patient care.

5) The ultimate goal of care coordination is to improve healthcare delivery. However, this goal is challenging to achieve when patient care is provided across boundaries.

These five key elements of care coordination (McDonald et al., 2007) can be used to describe the team that is involved in care coordination. Care coordination is performed by a team of individuals (1) with different expertise who work (2) towards a common goal of improving healthcare delivery (3). Team members exchange patient information to coordinate patient care (4). Team members may work across organizational, geographical and temporal boundaries. They need to understand each other's roles and expertise to coordinate patient care across boundaries (5).

2.3.2 Care coordination team

Care coordination is performed by a team of healthcare professionals and patients/caregivers. This research uses the classic definition of a team by Sundstrom et al. (1990): a team is a group of people who have interdependent tasks and work towards a common goal. Various theoretical concepts, models and frameworks have been developed to understand and improve teams and team performance (Salas, Cooke, & Gorman, 2010). For instance, shared cognition is an important concept to understand how teams obtain necessary knowledge to perform activities, including common knowledge among team members (i.e. team mental models) and knowledge of team member expertise (i.e. transactive memory systems) (Kozlowski & Ilgen, 2006).

Teams need to communicate, cooperate and coordinate to perform effectively (Salas et al., 2008). Salas et al. (2008) developed a set of guidelines for healthcare teams to improve their communication, cooperation and coordination, which can lead to better team performance and care delivery. These guidelines include protocols to support precise and accurate communication, identification of communication failure, and use of strategies such as pre-planning to improve team coordination (Salas et al., 2008). These guidelines can be used to improve communication, cooperation and coordination between people involved in care of chronically ill patients.

The people (e.g., physician, nurse, social worker) involved in care coordination of chronically ill patients, including those with CHF and COPD, form a care coordination team (Stille, Jerant, Bell, Meltzer, & Elmore, 2005). In a previous study (Kianfar et al., 2013), we conducted interviewees with 21 participants involved in care of CHF and COPD patients. Interview participants included 13 care managers, 2 administrators, 3 physicians and 3 nurses. We asked

participants to think about a care coordination team and to describe the members of the team. All participants recognized existence of a care coordination team. Participants identified various individuals as members of the care coordination team. We categorized members of the care coordination team for CHF and COPD patients into 7 groups (see Appendix 1):

1) Patients and families
2) Physicians; e.g., hospitalist, specialist, primary care physician
3) Nurses; e.g., inpatient nurse, clinic nurse
4) Discharge planners/care managers; e.g., inpatient care manager, outpatient care manager, social worker
5) Ancillary providers; e.g., therapist, pharmacist, dietitian
6) Home; services e.g., home health agency, hospice
7) Others; e.g., nursing home, office staff, technology

Now that we have identified the members of care coordination team for chronically ill patients, the next step is to understand the team members' activities performed to coordinate patient care.

2.4 Coordination

This section is intended to 1) review relevant definitions of coordination and 2) identify coordination activities from the literature.

2.4.1 Definitions of coordination

Various disciplines, such as management science, computer science and organization science, propose definitions of coordination (Malone & Crowston, 1990, 1994). Many definitions are generic and do not identify specific characteristics of coordination that distinguish this concept from other concepts such as communication (Malone & Crowston, 1990). This section reviews four definitions of coordination from the human factors and computer-supported cooperative work disciplines that describe unique characteristics of coordination. These definitions help to understand the concept of coordination and identify coordination activities.

2.4.1.1 Definition of coordination by Malone and Crowston (1990)

Malone and Crowston (1990) started with a generic definition of coordination theory: "a body of principles about how activities can be coordinated, that is, about how actors can work together harmoniously" (p. 358). This definition implies that a group of people need to perform some activities in a "harmonious" fashion. The word "harmonious" implies that the activities are interdependent. Therefore, a more specific definition of coordination is: "the act of managing interdependencies between activities performed to achieve a goal" (Malone & Crowston, 1990, p. 361).

Interdependency is a unique characteristic of coordination. As Malone and Crowston (1990) explain, "If there is no interdependence, there is nothing to coordinate" (p. 362). Interdependencies are "common objects" that are included in different activities and that determine how and in what order activities are performed. For example, consider a chronic

patient who is monitored by a primary care physician. The patient was hospitalized for a period of time and is now discharged home. The patient has a follow-up appointment with the primary care physician. The primary care physician needs discharge instructions to learn about decisions made at the hospital and to make necessary changes to the patient's plan of care such as medications. The common objects in this example are the discharge instructions that determine primary care physician's subsequent activities.

Malone and colleagues (Malone & Crowston, 1990; Malone et al., 1999; Malone, Crowston, & Herman, 2003) have described different types of interdependencies. See Table 1 for their definition of interdependencies.

Table 1: Types of interdependencies (Malone & Crowston, 1990; Malone et al., 1999; Malone et al., 2003)

Interdependency	Definition
Flow	Output of an activity is needed by another activity (sequencing constraint).
Shared resources	A resource (e.g., information) is needed by two or more activities (resource allocation constraint).
Simultaneity	Two or more activities need to occur at the same time or cannot occur at the same time (timing constraint).

The definition of coordination by Malone and Crowston (1990), "the act of managing interdependencies between activities performed to achieve a goal", implies that coordination occurs within a team that performs a set of interdependent activities to achieve a common goal. The definition above can be applied to the care coordination team for chronically ill patients: members of this team have interdependent activities and need to coordinate their activities to

manage care of chronically ill patients. The different types of interdependency described by Malone and Crowston (1990) can be used to identify coordination activities performed by team members coordinating care for chronically ill patients.

2.4.1.2 Definition of coordination by Klein (2001)

Klein (2001) defines coordination as "the attempt by multiple entities to act in concert in order to achieve a common goal by carrying out a script/plan they all understand" (p. 70). This definition implies that coordination is performed in a team whose activities are interdependent. Acting in concert implies that there are interdependencies between team members' activities. Similarly to Malone and Crowston (1990), Klein (2001) emphasizes that managing interdependencies is an important part of coordination.

Klein (2001) describes five stages of coordination:

- Preparation: team members familiarize themselves with the project before their planning meeting by reviewing available background information.
- Planning: team members meet and engage in brainstorming, decision-making and other activities that will help them develop a plan and establish common ground.
- Direction: the team operationalizes the plan and develops a set of actions.
- Execution:
    - Monitoring: due to the interdependence between team members' activities, team members need to monitor the progress of the plan to avoid any surprises when changes occur in the situation.

    - Triggering conditions: team members use triggering conditions (e.g. cues, alerts) to monitor the situation.
    - Aligning: team members make necessary adjustments to exchange information and deliver the final product.
- Assessment: the team uses outcome and process feedback to evaluate their performance and make changes if needed.

Klein (2001) emphasizes the "plan" that all team members need to understand. He identifies planning as a coordination stage in which team members meet and discuss important decisions. Planning may not be possible for teams that work across organizational, geographical and temporal boundaries. For example, members of the care coordination team of chronically ill patients may be located in different organizations and not even know each other. They may perform the preparation stage on their own to get familiar with the patient and his/her condition, but they may not be able to meet and discuss the plan of care. They communicate with each other to monitor the patient situation, use triggers to anticipate next steps and align their activities to take care of the patient. Using feedback from each other or the patient, team members evaluate the plan of care and make changes if needed. Therefore, out of the five stages of coordination identified by Klein (2001), three, i.e. preparation, execution (monitoring, triggering, aligning) and assessment, are particularly relevant for care coordination of chronically ill patients.

2.4.1.3 Definition of coordination by Salas et al. (2008)

Salas et al. (2008) propose a framework for effective teamwork in healthcare that includes communication, coordination and cooperation. Communication is exchange of information between team members. Coordination is "a familiar set of explicit or implicit behavioral strategies that occur whenever a group works together to achieve a set of target tasks" (Salas et al., 2008, p. 336). Cooperation is "the mechanisms required to motivate and maintain the group as a team" (Salas et al., 2008, p. 339). These three concepts are interrelated in the framework: coordination requires communication, which cannot happen without cooperation (Salas et al., 2008). For example, a care manager needs to arrange resources, such as home services, for a patient prior to hospital discharge (coordination). A physician informs the care manager of anticipated discharge date for the patient (communication). The physician informs the care manager since they are all part of a team and work towards a common goal (cooperation).

Salas et al. (2008) differentiate explicit and implicit coordination. Explicit coordination involves planning and strategizing and implicit coordination involves anticipating team members' actions and responding to them without explicit communication (Salas et al., 2008). Explicit communication means exchanging information in an efficient, accurate and precise manner to ensure that the information communicated was received and understood correctly (Salas et al., 2008). According to Salas et al. (2008), "expert teams" use implicit coordination, especially in stressful and time pressing situations to preserve performance. Team members need to practice skills such as communication and situation monitoring to be able to switch from explicit to implicit coordination when needed. To do so, team members need to have experience in

working together; this is easier to achieve when the members of the team remain the same (Salas et al., 2008). Team members need to develop a shared mental model to support each other in emergency situations.

Implicit coordination may not be possible in teams that do not work together frequently and, therefore, cannot develop a shared mental model. For example, the members of the care coordination team of chronically ill patients may not personally know each other; they may communicate using the electronic health record. Members of this team frequently change because of changing patients' needs or conditions. For example, an inpatient care manager may be part of the team while a patient is in the hospital, but after the patient gets discharged an outpatient care manager may be part of the team instead. It is recommended that teams use implicit coordination for emergency situations and explicit coordination in other situations (e.g. meetings) (Salas et al., 2008). It is unlikely that care coordination teams for chronically ill patients can rely on implicit coordination; explicit coordination is more relevant for this type of team.

2.4.1.4 Definition of coordination by Gittell (2002)

Gittell (2002) refers to coordination as "a process of interaction among participants" (p. 1410). Gittell (2000, 2002) introduced the concept of relational coordination, which is comprised of 1) communication (frequent, timely, accurate and problem solving) and 2) relationship (shared goals, shared knowledge, mutual respect. Shared goals motivate team members to value the common goal of the team. Shared knowledge keeps team members informed about each other's

work. Mutual respect helps team members consider the impact of their work on other members' work (Gittell, 2002).

Relationships between team members impact the quality (frequency, timeliness, accuracy, problem-solving) of their communication. Quality of communication affects team members' ability to manage interdependencies between their activities, i.e. coordinate their work. In the context of care coordination of chronically ill patients, strong relationships can facilitate communication between team members. For example, an inpatient care manager needs to know when a physician decides to discharge a patient so that s/he can perform the discharge planning activities. If the discharge decision is not communicated to the care manager in a timely manner, the patient may leave the hospital without any arrangements made before actual discharge (poor coordination). If a relationship has been established between the physician and the care manager, the physician is more likely to communicate the discharge decision to the care manager in a timely manner and the care manager can coordinate the transition of the patient out of the hospital.

2.4.1.5 Summary of coordination definitions

Table 2 summarizes the definitions of coordination described in section 2.4.1. These definitions recognize that coordination occurs within a team whose members have interdependent activities; the team members need to manage those interdependencies to achieve a common goal. Only Malone and Crowston (1990) provide a framework for understanding the different types of interdependencies. Their framework, is therefore, particularly important because

interdependencies are the main characteristic of coordination. Malone and Crowston's (1990) framework can be used to identify coordination activities, which is one of the aims of this research. Therefore, this study uses the definition of coordination and conceptual framework by Malone and Crowston (1990).

Table 2: Definitions of coordination

Authors	Definitions of coordination
Malone & Crowston (1990)	"The act of managing interdependencies between activities performed to achieve a goal" (p. 361).
Klein (2001)	"The attempt by multiple entities to act in concert in order to achieve a common goal by carrying out a script/plan they all understand" (p. 70).
Salas et al. (2008)	"A familiar set of explicit or implicit behavioral strategies that occur whenever a group works together to achieve a set of target tasks" (p. 336).
Gittell (2002)	"The process of coordination was conceptualized as relational coordination" (p. 1413). "Relation coordination reflects the role that frequent, timely, accurate, problem solving communication plays in the process of coordination, but it also captures the oft-overlooked role played by relationships" (p. 1410).

The definitions of coordination emphasize communication as a major part of coordination. Communication enables team members to exchange information about the activities they perform (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990; Salas et al., 2008).

Monitoring was described by Klein (2001) and Salas et al. (2008) as an important part of coordination. Monitoring enables team members to become aware of progress of activities that they depend on so that they can prepare for next steps (Klein, 2001).

Based on the definitions of coordination presented in Table 2, communication and monitoring have an important role in managing interdependencies between activities (i.e. coordination). Coordination activities are "actions that help achieve coordination" (McDonald et al., 2011, p. 12), and, therefore, include communication and monitoring.

2.4.2 Coordination activities

2.4.2.1 Communication

Communication has been described as an essential coordination activity (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990; Salas et al., 2008). Communication is the exchange of information between team members (Salas et al., 2008). Communication has four components: context, content, people involved and purpose (Lingard et al., 2004). Content is the information exchanged or "what is said" (Lingard & Haber, 1999). Context is the "physical and temporal situation of an exchange" (Lingard et al., 2004, p. 331). People involved refers to "composition of group engaged in communication" (Lingard et al., 2004, p. 332). Purpose refers to goals of the communication (Lingard et al., 2004, p. 331)

Communication enables different people involved in the coordination, i.e. team members, to plan their activities (Klein, 2001) and make decisions (Malone & Crowston, 1990). As explained in section 2.4.1.3, communication can be explicit or implicit. However, for the care coordination

team that is the focus of this research, explicit communication is more relevant than implicit communication.

2.4.2.2 Monitoring

Monitoring is about evaluating the progress of activities (Klein, 2001; Salas et al., 2008). There are three types of monitoring (Klein, 2001):

- Monitoring progress of the plan: team members need to monitor each other's progress on the plan and be prepared for next steps of the plan.
- Monitoring changes in the situation: team members need to monitor changes in the situation and then adjust their work.
- Monitoring other members: team members need to monitor each other's workload and work demand to identify if any support is needed.

Monitoring is an essential activity for the care coordination team of chronically ill patients. Members of this team have interdependent activities. Monitoring patient status helps team members prepare for their next steps. For example, a primary care physician knows that a patient has visited a specialist. The primary care physician looks into the health IT to read the specialist's notes so that he/she is prepared for the next patient visit.

Monitoring has been identified as an essential part of care managers' work (Maliski et al., 2004; Oliva, 2010). Care managers monitor patients' symptoms and progress on a regular basis. They

also monitor patient records to become aware of patients' visits, ensure appropriate services are set up for the patients and identify any abnormal test results (Carayon et al., 2015; Maliski et al., 2004; Oliva, 2010).

Monitoring activities may or may not involve communication. For example, a care manager may review the patient's chart on a regular basis to stay informed about the patient's status. In this case, the monitoring activity does not involve communication. A care manager may talk to the patient's family on a regular basis to be informed about the patient's status and inform the primary care physician about the patient. In this case, monitoring involves communication.

2.4.3 Factors impacting coordination activities

Care coordination is influenced by the work system of care coordination team. Members of care coordination team perform a range of activities using various tools and technologies. Care coordination is performed in a particular physical environment and under certain organizational conditions. People, activities, tools and technologies, physical environment and organizational conditions are work system factors (Carayon et al., 2006) associated with care coordination. These work system factors interact with each other and produce care coordination process, which can result in different outcomes: good or poor coordination.

Work system factors may facilitate or hinder care coordination (Carayon et al., 2006). Carayon et al. (2014) discuss the importance of understanding work system barriers and facilitators in any

work system analysis and redesign. This information can be used to inform subsequent redesigns (i.e. assessing impact of redesign on work system). To study care coordination systematically, it is worthwhile to identify work system factors influencing the care coordination process and outcomes associated with care coordination. This can be done with the SEIPS model (Carayon et al., 2006; Carayon et al., 2014).

Relationship building (section 2.4.1.4) is a work system factor that can facilitate or hinder coordination for chronically ill patients (Powers et al. 2015; Boling 2014; Gittell 2002). Having strong relationships can facilitate communication between the team members and help them better manage the interdependencies between their activities (i.e., coordinate). For example, a care manager who has a good relationship with a home health agency in the community may to inform them of patient arrival time to home, so that the home health agency arrives to patient home at the right time. In an earlier study on perceived impact of care managers on patient and clinician outcomes, we found that relationship building with patients and clinicians is particularly important for care managers who work in outpatient settings (Carayon, Hundt, et al., 2015). In this research, we identify a range of work system factors that influence care coordination.

2.5 Conclusion of literature review

Coordination of care is particularly important for chronically ill patients, such as those with CHF and COPD. Healthcare professionals (e.g., physician, care manager, nurse) in different care settings (e.g., hospital, physician office, nursing home) are involved in caring for these patients.

They depend on each other to perform patient care activities. As described in section 2.2.1, challenges exist in coordinating care for chronically ill patients, such as limited information exchange and lack of follow up care. Different interventions such as care management have been implemented to improve care coordination for chronically ill patients. These interventions may result in improvement in care coordination and patient outcomes. However, it is not clear what aspects of the interventions contribute to the improvement. Therefore, there is a need for a deeper understanding of care coordination.

Coordination is a widely used concept in many different disciplines. Coordination happens in a team and has common characteristics with other concepts such as communication and cooperation (section 2.4.1.3). Coordination is sometimes used interchangeably with these other concepts, in particular communication. A number of definitions in the literature describe characteristics of coordination (section 2.4.1). These definitions identify interdependency as the main characteristic of coordination. The definitions also identify communication and monitoring as types of coordination activity (section 2.4.2). Work system factors such as relationship building can facilitate or hinder care coordination (section 2.4.3).

Chapter 3: Research Questions

3.1 Research Question 1

RQ1: What care coordination activities do healthcare professionals involved in the care of chronically ill patients perform?

In section 2.4.2, we identified communication and monitoring as coordination activities. In section 2.4.1.1, the existence of interdependencies between activities was identified as the main characteristic of coordination. If there are no interdependencies between activities, there is no coordination. Therefore, it is important to consider interdependencies when identifying care coordination activities. This study uses the definition of coordination and framework of interdependencies by Malone and colleagues (Malone & Crowston, 1990; Malone et al., 1999; Malone et al., 2003) described in section 2.4.1.1.

3.1.1 Conceptual framework for care coordination

As described in section 2.3.2, healthcare professionals involved in care of chronically ill patients, including those with CHF and COPD, form a care coordination team. The framework shown in Table 3 is used for identifying care coordination activities performed by the care coordination team of CHF and COPD patients. This framework has two dimensions:

1) Coordination activities
2) Interdependencies

Table 3: Examples of care coordination activities (Kianfar et al., 2014)

Coordination activities	**Interdependencies**		
	Flow: Output of activity1 used by activity2	**Shared resource:** A resource needed by multiple activities	**Simultaneity:** Activities need to occur at the same time
Communication	Activity1: Primary care physician assesses the patient and develops a plan of care. Activity2: Care manager arranges resources (e.g. equipment, therapy) for the patient based on the plan of care. Plan of care produced from activty1 is used by activity2.	Activity1: Care manager or social worker sends patient information to home health agency. Activity2: Home health agency reviews patient information. Both activities need patient information (resource).	Activity1: Care managers or social worker asks patient about estimated arrival time to home. Activity2: Care manager or social worker informs home health agency of arrival time of patient to home. Activity1 and activity2 are needed for patient and home health nurse to arrive at patient home at the same time.
Monitoring	Activity1: Care manager monitors patient at home using phone calls or telemonitoring system. Activity2: Care manager needs to ensure patient symptoms and ensure they are under control. Patient information produced by activity1 is used by activity2.	Activity1: Care manager monitors patient at the nursing home by making follow up calls to the nursing home. Activity2: Care manager needs to ensure patient is receiving proper care at nursing home. Both activities need patient information (resource).	

3.1.1.1 Coordination activities

As described in section 2.4.1.5, coordination activities are "actions that help achieve coordination" (McDonald et al., 2011, p. 12). Coordination activities include communication and monitoring.

1. Communication is the "exchange of information between a sender and a receiver" (Salas et al., 2008, p. 335). Communication occurs when two or more people involved in the care of a chronically ill patient, i.e. members of the care coordination team, exchange information related to this patient. As mentioned in section 2.3.2, members of the care coordination team include patients and families, physicians, nurses, discharge planners/care managers, ancillary providers, home services and other (Kianfar et al., 2013). Team members exchange information synchronously (e.g., in person, via phone) or asynchronously using technologies such as instant messaging and EHR.

2. Monitoring is about evaluating the progress of activities. "Team members need to monitor the progress of the plan and also monitor changes in the situation" (Klein, 2001, p. 77). Team members need to review the progress of patient-related activities they are involved in to ensure patient needs are addressed. If changes occur in the patient's situation (e.g., change in symptoms), team members should make necessary adjustments to the patient care plan and resource arrangement (Klein, 2001; McDonald et al., 2011). Monitoring activities may or may not involve communication.

3.1.1.2 Interdependencies

As mentioned in section 2.4.1.1, there are 3 types of interdependencies: flow, shared resources and simultaneity (Figure 1). A coordination activity may have more than one type of interdependency.

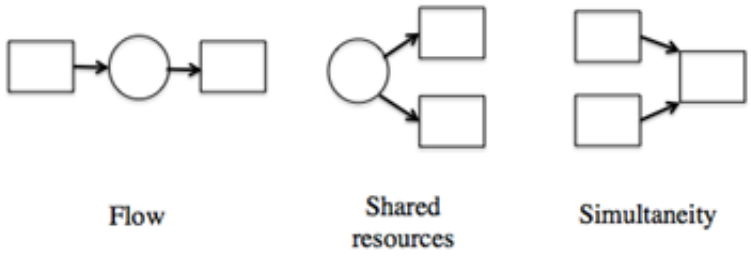


Figure 1: Different types of interdependencies. Boxes show activities and circles show resources/outputs. Adapted from (Malone et al., 2003). A breakdown in boxes, circles or arrows can lead to poor coordination.

1. Flow: Output of an activity is used by another activity (sequencing constraint) (Malone & Crowston, 1990). The former is a producer activity and the latter is a consumer activity. The output of the producer activity may be information or a physical item that will be transferred to and used by the consumer activity (Malone & Crowston, 1994). For example, a primary care physician assesses the patient and develops a plan of care (producer activity); a care manager arranges resources for the patient based on the plan of care (consumer activity).

2. Shared resources: A resource is needed by two or more activities (resource allocation constraint) (Malone & Crowston, 1990). In other words, two activities have sharing dependency when "both have the same resource as a precondition" (Malone et al., 2003, p. 97). A resource is "everything used or affected by activities" (Malone et al., 2003, p. 91). A resource can be information, space, equipment, money, service or a person. For example, a care manager or

social worker sends patient information to a home health agency staff; the home health agency staff reviews patient information. Patient information is the resource needed by both activities.

3. Simultaneity: Two or more activities need to occur at the same time (Malone & Crowston, 1990) or cannot occur at the same time (Malone & Crowston, 1994) (timing constraint). For example, a care manager or social worker asks the patient about his/her estimated arrival time at home; the care manager or social worker informs the home health agency of the patient's arrival time at home. Both patient and home health nurse need to arrive to the patient's home at the same time.

3.1.2 Conceptual framework for factors impacting care coordination activities

As described in section 2.4.3, the care coordination process is affected by work system factors of people involved in care coordination. Work system factors may facilitate or hinder the care coordination process. The care coordination process can then result in good or poor coordination.

The focus of RQ1 is on identifying care coordination activities. This study also identifies work system factors contributing to the care coordination process and outcomes using the SEIPS model shown in Figure 2.

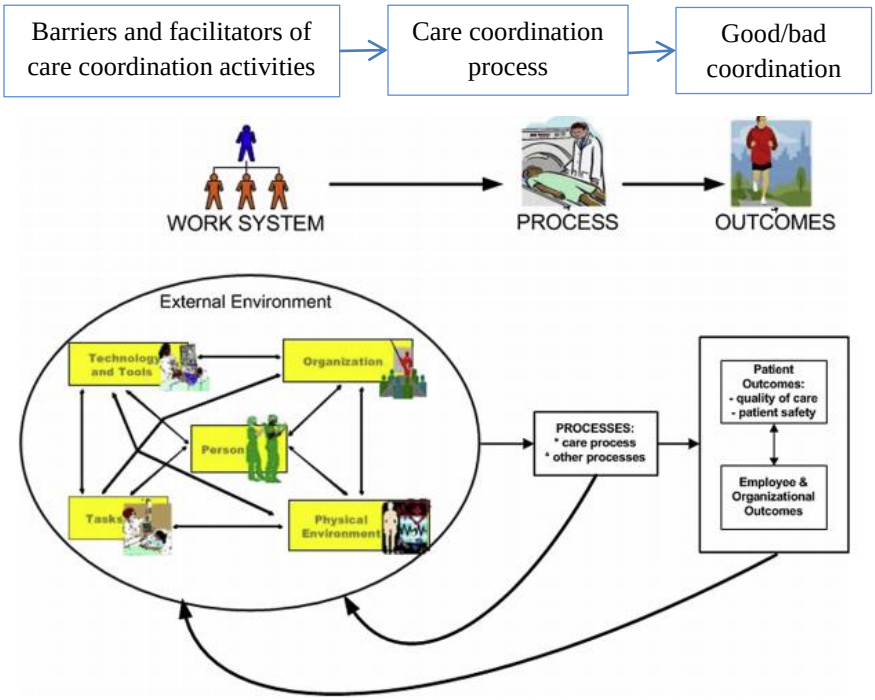


Figure 2: Adaptation of the SEIPS model (Carayon et al., 2006, 2014) to care coordination

3.2 Research Question 2

RQ2: How do healthcare professionals involved in the care of chronically ill patients communicate to coordinate patient care?

As discussed in section 2.2, coordinating care during transitions can be a challenge, and care coordination interventions should focus on communication during these transitions. For the second research question, this study focuses on communication that occurs between care coordination team members to notify one another of patient admission, discharge, transfer or ED visit, i.e. transitions of care.

3.2.1 Conceptual framework for communication

Communication is the "exchange of information between a sender and a receiver" (Salas et al., 2008, p. 335), and is an essential coordination activity (section 2.4.2.1). As described in section 2.4.1.3, Salas et al. (2008) adopted the framework of communication by Lingard et al. (2004) to describe communication in their model of teamwork in healthcare. This study uses the framework by Lingard et al. (2004) to study the communication involved in notification of CHF and COPD patient transitions among care coordination team members (see Table 4). According to this framework, communication has four components: content, context, people involved and purpose (Lingard et al., 2004).

1. Content: the information exchanged or "what is said" (Lingard & Haber, 1999). In this study, content refers to notification of admission, discharge, transfer or ED visit.

2. Context: "physical and temporal situation of an exchange" (Lingard et al., 2004, p. 331). Context refers to medium of communication and timing of information exchanged. Medium is the method used to exchange information (e.g., face-to-face, phone call, email, instant message, paper chart, message sent through health IT). Medium determines the timing of information exchanged. Timing is synchronous when there is no delay in receiving the information (e.g., face-to-face, phone call, instant message). Timing is asynchronous when delay exists in receiving the information (e.g., email, paper chart, message sent through health IT).

3. People involved: “composition of group engaged in communication” (Lingard et al., 2004, p. 332). People involved in the communication either send or receive information. People involved in the communication include those in the inpatient setting, outpatient setting or ED. People also include patients at home.

4. Purpose or goals of the communication (Lingard et al., 2004, p. 331). Goals of communication related to care coordination include simple notification of patient transition or providing additional information about the patient.

Chapter 4: Methods

4.1 Study design

My worldview is pragmatic. Pragmatic worldview "emphasizes the research problem and use all approaches available to understand the problem" (Creswell, 2009, p.10). Therefore, I use approaches that help me answer the research questions described in chapter 3.

I used a qualitative approach for RQ1 and a mixed methods approach (Creswell & Plano Clark, 2011) for RQ2 using data collected through semi-structured interviews. Table 4 shows a summary of research questions and associated methods.

Table 4: Research questions and associated methods

Research questions	Methods
RQ1: What care coordination activities do healthcare professionals involved in the care of chronically ill patients perform?	Twelve interviews with 1 primary care physician, 8 care managers (5 outpatient, 3 inpatient), 1 inpatient social work administrator, 1 nursing home social work administrator, and 1 home health agency administrator
RQ2: How do healthcare professionals involved in the care of chronically ill patients communicate to coordinate patient care?	Secondary data analysis of 60 interviews: 41 interviews conducted with 15 care managers (5 inpatient, 3 outpatient, 5 TOC and 2 float) on 1-6 occasions, and 19 interviews with 18 other healthcare professionals (3 physicians, 5 nurses, 5 discharge planners, 5 administrators) on 1-2 occasions.

4.2 Study setting

This study was part of a larger project on health IT-supported care management, i.e. the Keystone Beacon project in central Pennsylvania (www.keystonebeaconcommunity.org). The Keystone Beacon project focused on patients with CHF and COPD. As described in section 2.1, these patients need care coordination to help manage their condition and avoid hospitalization (McDonald et al., 2007). If patients get hospitalized, they need additional coordination for discharge planning and monitoring their clinical condition. The objective of the Keystone Beacon care management model was to help patients better manage their condition; the ultimate goal was to reduce or prevent admissions, readmissions, and emergency department visits.

4.2.1 Keystone Beacon Project

The Keystone Beacon project is a unique model for care coordination; it captures the entire spectrum of patient journey including hospitals, primary care clinics, skilled nursing facilities and home health agencies. This project provides a unique opportunity to study care coordination and answer the research questions. The Keystone Beacon project was funded by the US Department of Health and Human Services Office of the National Coordinator for Health IT. There were a total of 17 Beacon projects across the US. The Keystone Beacon project was a leader in using health IT for care coordination.

The Keystone Beacon project involved 4 hospitals, a number of primary care clinics, nursing homes and home health agencies in central Pennsylvania. These healthcare organizations were

independently managed, and all worked together to coordinate care for CHF and COPD patients. Table 5 shows characteristics of the four participating hospitals.

Table 5: Characteristics of the four participating hospitals in Keystone Beacon project in 2012

Characteristics	Hospitals			
	A	B	C	D
Size	600+-bed	135-bed	68-bed	72-bed
Discharges[1]	26,211	5,601	2,363	3,267
EHR implemented	Yes	Yes, limited[2]	Yes	Yes, limited[3]

Note: [1]From hospital's Medicare cost report. [2]No physician progress notes. [3]Mainly paper

The Keystone Beacon project took place in a five-county rural area of central Pennsylvania. The majority of Keystone Beacon patients are 60-80 years old with relatively low socioeconomic status. Patients in rural areas face challenges such as transportation, access to specialists, lower education and lower income; these factors impact their health (Effken & Abbott, 2009; Quarells, Liu, & Davis, 2012) and complicate care coordination. Care coordination for this patient population can be more challenging and additional efforts may be needed compared to a patient population in an urban area with better socio-economic conditions.

The goal of this research is to capture as broad domain of care coordination activities for chronically ill patients as possible. The Keystone Beacon project 1) focused on chronically ill patients, 2) covered the entire spectrum of patient journey and 3) involved care managers who were hired to coordinate care for chronically ill patients. The setting in the Keystone Beacon project is, therefore, a good fit for this research.

4.2.2 Care managers

The Keystone Beacon care management model includes three types of care manager: inpatient, outpatient and transitions of care (TOC) center (see Figure 3). Inpatient care managers work in the four hospitals and manage the care of patients in the hospital; they also contribute to the discharge process. Outpatient care managers work in primary care clinics and manage CHF and COPD patients as long as needed. Some primary care clinics in the five Keystone Beacon counties do not have an outpatient care manager to follow Keystone Beacon patients discharged from any of the four participating hospitals. Therefore, a TOC center was established to follow discharged Keystone Beacon patients. TOC care managers make weekly phone calls to Keystone Beacon patients who are discharged from the hospital, for a total of 30 days post-discharge. Float care managers cover for care managers when needed (e.g., vacation, turnover). Patient load of care managers ranges between 30-150 patients.

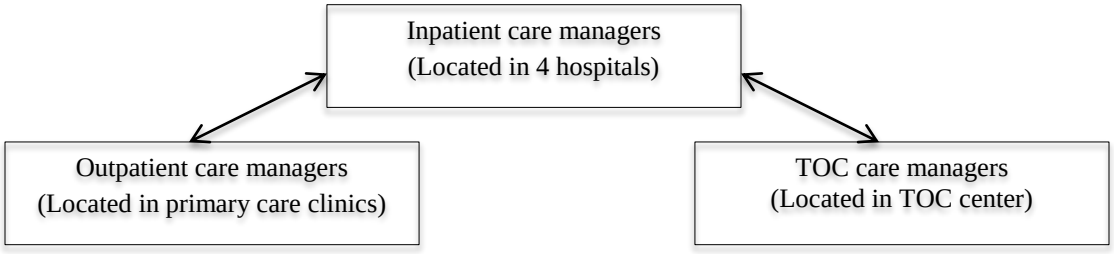


Figure 3: Keystone Beacon care management model

Note: arrows show information flow between inpatient, outpatient or TOC care managers

Care managers in the Keystone Beacon project perform different activities. In a previous analysis (Carayon, Hundt, et al., 2015), we identified those activities and asked care managers which of these activities influence patient and clinician outcomes. These activities include:

1) Ensuring primary care physician (PCP) follow-up and contacting the PCP on behalf of patients
2) Coordinating appropriate services
3) Providing patient education
4) Using health information technology
5) Ensuring patients have proper equipment
6) Performing medication reconciliation
7) Focusing on patients with higher need
8) Building relationships with patients
9) Supporting or helping clinicians
10) Building trust with clinicians.

Not all of the activities listed above are care coordination activities. Activities 3, 4, 6, 7, 8, and 10 are not care coordination activities because they lack interdependency. For example, providing patient education involves communication with patients, but does not depend on other activities or is not a requirement for other activities. One of the objectives of this research is to identify care coordination activities performed for chronically ill patients through identifying interdependencies.

4.3 Methods for Research Question 1

4.3.1 Sample

A total of 12 healthcare professionals participated in this study (see Table 6).

Table 6: Participants recruited for RQ1

Care coordination member category	Title	# of participants
Physicians	Primary care physician (PCP)	1
Discharge planners/ care managers	Outpatient care managers (OP CM)	5
	Inpatient care managers (IP CM)	3
	Inpatient social work administrator (IP SW)	1
Home services	Nursing home social work administrator (SNF SW)	1
Other	Home health agency administrator (HH)	1
	Total	12

In qualitative research, purposeful sampling is used to choose participants that can provide information about a concept (Sandelowski, 1995). We recruited the 12 participants listed in Table 6 for the study because they are involved in care coordination of Keystone Beacon patients (i.e. patient with CHF and COPD) and can provide information about care coordination activities performed for Keystone Beacon patients. We selected participants (Creswell, 2009, p. 178; Robson, 2011, p. 275) based on the following criteria:

1) Be among the 7 categories of members of the care coordination team (Kianfar et al., 2013) mentioned in section 2.3.2. The 7 categories are listed below. For this study, we were able to recruit participants from 4 categories, which are listed in parentheses.
    a. Patients and families
    b. Physicians (1 participant: PCP)
    c. Nurses
    d. Discharge planners/care managers (9 participants: 8 CM, 1 IP SW)
    e. Ancillary providers
    f. Home services (1 participant: HH)
    g. Other (1 participant: SNF SW)

2) Work at Keystone Beacon facilities (hospitals, clinics and nursing homes)

3) Be available during the data collection period.

For the first research question, we needed a sample to identify care coordination activities. It is important for the sample to include all healthcare professionals involved in care coordination of chronically ill patients. Our participants belong to 4 of the 7 categories of members of the care coordination team. Having participants from the other 3 categories, especially patients, could have enriched our data; this is a possible limitation of the sample that is discussed later. However, to compensate for this possible limitation, we obtained information from our participants about categories of members that were not included in our sample. For example, care managers and social workers provided information about their interactions with nurses, patient/families and ancillary providers (e.g., pharmacist, therapist). Primary care physicians provided information about their interactions with specialists, hospitalists and patients/families. This approach helped our sample to be "informationally representative" (Sandelowski, 1995) because we obtained information from participants who interacted with other members of the care coordination team and could talk about coordination activities that those members perform.

4.3.1.1 Theoretical saturation

To ensure that our sample size is sufficient to answer the first research question, we used the theoretical saturation criterion. According to Corbin and Strauss (2014), saturation is "when no new themes or relevant categories are emerging" (p. 139); this requires a deep understanding of

categories and their dimensions and characteristics. We developed our care coordination framework before data collection and used the framework to guide the interviews. Thus, we had an understanding of care coordination activities (communication, monitoring) and their characteristics (interdependencies).

During data collection, our research team debriefed after conducting each interview to discuss the data we collected with respect to our conceptual framework. In the debriefings, we learned that we were obtaining consistent information about care coordination activities, i.e. communication and monitoring with various types of interdependencies.

During data analysis, as I coded the interviews, I checked for saturation to determine if additional data were needed to answer the first research question. I tracked how many coded instances I found in coordination activities (communication and monitoring) and interdependencies (flow, shared resources and simultaneity). I started the coding process with the most informationally-rich interview and alternated between interviews with participants from different care settings to account for variation. The numbers of new coded instances in each type of coordination activity and interdependency had a decreasing trend as I coded all of the interviews. The activities and interdependencies I identified were consistent with those in the conceptual framework described in section 3.1.1. I found activities that involved both communication and monitoring or activities that involved both flow and shared resources interdependencies, but I did not find any new types coordination activities or interdependencies.

Therefore, I reached saturation at the level of coordination activities and interdependencies with the 12 interviews.

4.3.2 Data collection

Our research group conducted face-to-face semi-structured interviews to collect data on care coordination activities performed by healthcare professionals involved in care of Keystone Beacon patients. Semi-structured interviews allow follow-up questions that provide an opportunity to get more detailed answers from the participants (Robson, 2011). Interview guides were developed for data collection.

4.3.2.1 Interview Guide Development

Several steps were taken to develop the interview guides:

Step 1: We developed a diagram of the journey for Keystone Beacon patients and their transitions through different care settings, such as hospital, nursing home and outpatient clinics (see Figure 4). A patient may get admitted to a hospital (1) and discharged to either home or a nursing home (2). A patient may be discharged home from the nursing home (3). Different clinics and community services may visit the patient at home (4). It is possible that the patient gets readmitted to the hospital from home or nursing home (5) and this cycle continues. These 5 stages of patient journey correspond to the numbers in Figure 4.

Step 2: Based on the patient journey diagram (Figure 4), we identified three generic care processes that require coordination and involve patient transitions between different care settings. Table 7 describes each of the three care processes and examples of associated interdependencies (see Appendix 3 for more details).

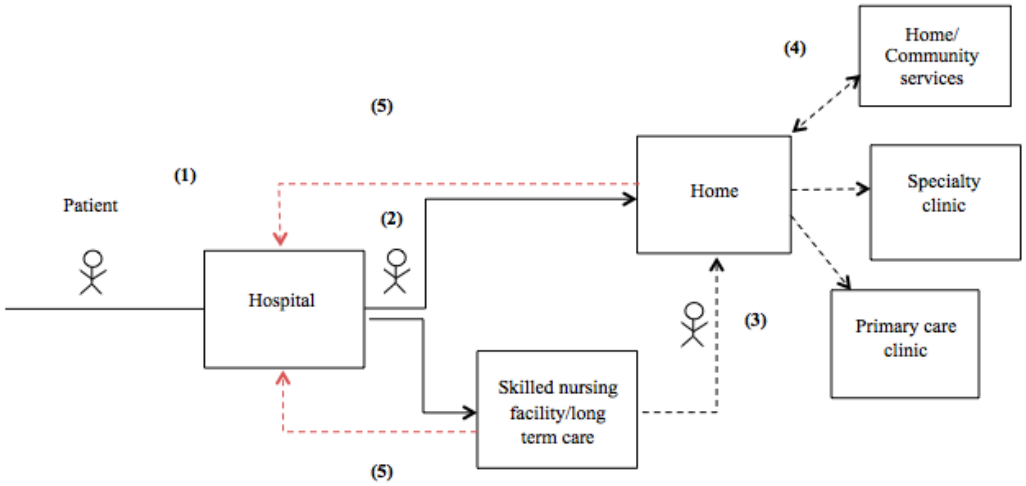


Figure 4: Patient journey

Note: arrows show patient transition to different care settings. Dotted black arrows show patient journey to home/community services or physician offices. Dotted red arrows show patient re-admission to hospital. The numbers in the figure refer to different stages of patient journey as described in step 1.

Table 7: Care processes requiring coordination and examples of associated interdependencies

Care processes	Examples of interdependencies
Patient admitted to hospital and discharged home with home health	*Simultaneity interdependency* - HH provider needs to work with other home services providers, such as durable medical equipment (DME) provider to make sure patient has the right equipment when he/she gets home.
Patient admitted to hospital and discharged to nursing home	*Shared resources* – Patient information needs to be shared between hospital and nursing home to manage patients properly. *Flow interdependency* – Care manager performs some activities such as medication review and making follow up appointment, to make sure patient is ready for transition to nursing home.
Patient visit to primary care physician	*Flow interdependency* – Care manager monitors patient at home using phone call or telemonitoring system to ensure patient symptoms are under control.

Step 3: We then identified the healthcare professionals involved in each of the three care processes (see Table 8). Check marks in Table 8 represent involvement of the healthcare professionals in the care processes.

Table 8: Care processes requiring coordination and healthcare professionals involved

Care processes requiring coordination	Healthcare professionals					
	PCP	OP CM	IP CM	IP SW	SNF SW	HH
Patient admitted to hospital and discharged home with home health	✓	✓	✓	✓		✓
Patient admitted to hospital and discharge to nursing home	✓	✓	✓	✓	✓	
Patient visit to primary care physician	✓	✓				

Note: PCP= primary care physician, OP CM= outpatient care manager, IP CM= inpatient care manager, SNF SW= nursing home social worker, HH= home health agency administrator.

Step 4: For each of the three care processes, we built a scenario of a situation in which coordination occurs (see Table 9). The scenarios involved patient transitions between different care settings, which require care coordination by different healthcare professionals. Thus, the scenarios provided a context for participants to answer questions about care coordination.

Table 9: Care coordination scenarios

Scenarios	Descriptions
Patient admitted to hospital and discharged home with home health	Consider a Keystone Beacon patient with CHF and COPD who experienced pulmonary exacerbations. Patient had medication changes in the hospital and was discharged home with home health services.
Patient admitted to hospital and discharged to nursing home	Consider a Keystone Beacon patient with CHF, COPD and diabetes, who requires continued nursing care and was discharged to a nursing home.
Patient visit to primary care physician	Consider a Keystone Beacon patient with CHF who has experienced a sudden weight gain and comes to clinic for an urgent visit.

Step 5: For each of the scenarios, we asked the following questions:

a. What is your role caring for this patient in this process?
b. Give us examples where the coordination for this patient was good and this process was well coordinated.
c. Give us examples where the coordination for this patient was poor and this process was poorly coordinated.
d. Probes/follow-up questions.

The first question helped understand what activities the participants or other team members perform to coordinate patient care. The second and third questions asked for examples of well-coordinated and poorly coordinated care, which helps to understand coordination activities that affect outcomes. We used probes/follow-up questions to collect further information from the participants. For example, to clarify what a participant said about their role in caring for a patient in a particular scenario, we repeated back to them what they described: *"I hear you saying…"*. When participants were potentially describing a care coordination activity, we asked additional questions to understand how they manage interdependencies: *"So how do you manage that?"*.

Step 6: Four interview guides were prepared based on the care processes that each interviewee was involved in. As shown in Table 8, primary care physicians and outpatient care managers are involved in the same care processes and, therefore, have the same interview guide. Similarly, inpatient care managers and hospital social worker administrators have the same interview guide. Home health providers and nursing home social worker administrators are each involved in different care processes and have different interview guides. All four interview guides are provided in Appendices 4A-4D.

4.3.3 Data collection procedures

We obtained Institutional Review Board (IRB) approval from participating healthcare organizations and the researchers' academic institution. Participants were recruited via email. Participation in the interviews was voluntary. Our research group included my advisor, two research scientists and me. We formed two data collection teams: team 1 included a research scientist and me and team 2 included my advisor and another research scientist. We conducted a total of 12 interviews: team 1 conducted 9 interviews and team 2 conducted 3 interviews. In each team, one person was responsible for asking questions and the other person was responsible for audio recording, taking notes and keeping track of questions asked. Interviews were conducted in December 2012 in the work offices of the participants. Interviews were audio-recorded after asking for consent from participants. All interviews were transcribed by a professional transcription service. The average duration of interviews was 51 minutes (min: 32 minutes; max: 1 hour and 3 minutes). The total duration for the 12 interviews was 10 hours and 11 minutes.

4.3.4 Data analysis

Table 3 in section 3.1.1 showed the two-dimensional framework of coordination activities and associated interdependencies. I used the framework to identify care coordination activities performed for CHF and COPD patients; this process involved a qualitative content analysis (Graneheim & Lundman, 2004).

4.3.4.1 Coding book development

The first step of the data analysis was to create a coding book that describes and operationalizes the conceptual framework. The purpose of the coding book was to serve as a guide or reference for coding the interviews. I started with the definitions of coordination activities and interdependencies from the literature, and further refined the definitions as I discussed the conceptual framework with my advisor. As I coded the data, I included examples and keywords for different concepts in the coding book. Creating the coding book was an iterative process and took about 12 revisions to reach the final version. Appendix 5 shows the final version of the coding book for RQ1.

4.3.4.2 Coding instructions

The second step in data analysis was to develop a procedure to code the transcribed interviews based on the definitions in the coding book. I developed a systematic procedure to ensure both dimensions of the care coordination framework (section 3.1.1) were coded. I developed an initial procedure and asked two graduate students to review my coding instructions; they provided feedback about the clarity of the steps. Then, I discussed the document with my advisor and further refined the coding instructions.

The final procedure required the coder to read the interview transcript five times:

1) First reading: get familiar with the interview content
2) Second reading: identify coordination activities
3) Third reading: identify interdependencies

4) Fourth reading: see if any additional coordination activities exist
5) Fifth reading: review the coding of coordination activities and interdependencies.

Appendix 6 shows the final version of coding instructions after about 10 revisions.

4.3.4.3 Data analysis procedure

My advisor and I each coded one interview independently using the coding book and coding instructions. We then compared the results of our coding. The purpose of this comparison was to check the clarity of the conceptual framework definitions and the coding procedure. We discussed differences in our coding. I then clarified the coding book and revised coding instructions. My advisor and I coded a second interview independently, compared the results of our coding and discussed the differences in our coding.

We coded interview transcripts on paper. After each round of coding, I created a table to record coordination activities and interdependencies that my advisor and I had marked on the transcripts (see Table 10). Then, I compared our coding using three colors: 1) white, for same codes identified by both coders, 2) orange, for codes identified by only one coder and 3) purple, for partially different codes identified by coders (see Table 10). The partial difference occurred when both coders had the same activity but different interdependency (flow vs. fit) or when one coder identified monitoring in addition to communication, but the other coder did not (see Table 11). These differences were minor considering that there were two dimensions to code and both coders had identified both dimensions, but assigned different codes. Therefore, I calculated the

coding agreement by adding the percentage of same codes and partially different codes identified by both coders. Note that the "fit" interdependency was initially part of our conceptual framework. But, after several iterations of coding and refining the conceptual framework, we decided that the "fit" interdependency was a combination of other types of interdependencies and, therefore, we removed it from our conceptual framework.

Table 10: Second round of coding between two coders

Coded instances	**Coder #1**		**Coder #2**	
	Coordination activity	Interdependency	Coordination activity	Interdependency
1	C, M	F	C, M	F
2	C, M	F	C, M	F
3	C, M	F	C, M	Fit?
4	C	Fit	C	Fit?
5	C, M	F	C, M	F
6	C	Fit	C	Fit
7	C	Fit		
8	C	Fit	C	F
9	C, M	F	C	Fit?
10	C	F	C	F
11	C	Fit	C	F
12	C	Fit		
13	C		C	
14	C		C	
15	C	F	C	
16	C	SR	C	SR
17	C	F		
18	C	F	C	F?
19	C		C	
20	C,M	F	C	Fit?
21	C	F	C	F?
22	C		C	
23	C		C	
24	C	F	C	F
25	M	F	C	F
	C,M	Fit		
26			C	
27	C	F	C	F
38	C	F	C	F
29	C	Fit	C	F or Fit or both?
30	C		C	
31	M		M	?

32	C	SR		
33			M	F, S?
34	C	?	C	?
35	C		C	?
36	C	F	C	F
37	C	F	C	F
38	C	?	C	?
39	C	Fit?		
40	C	?	C	?

Note: C=communication, M=monitoring, C,M= communication and monitoring, F=flow, SR=shared resources, S=simultaneity.

In the first round of coding, we reached 52% agreement. We discussed the differences in our coding and clarified the definitions of coordination activities and interdependencies in the coding book, and I revised the coding instructions. These strategies helped us reach 83% agreement in the second round of coding (see Table 11). After the second round of coding, I made further changes to the definitions in the coding book and added examples from the two interviews that we had coded. The process of independently coding interviews and comparing coding results insured reliability of data analysis procedure.

Table 11: Coding comparison analysis

Coding comparison	# of coded instances (total of 40)	Comments
Both coders identified the same code	26 (65%)	
Code identified by one coder, but not the other coder	7 (17.5%)	5 instances coded only by code #1; 2 instances coded only by coder #2
Partially different codes assigned to an instance	7 (17.5%)	4/7: same coordination activity; different interdependency 3/7: partially different in coordination activity (C, M vs. C) and interdependency (F vs. Fit)
Agreement	33 (83%)	65%+17.5%= 82.5% 65% complete agreement and 17.5% agreement with minor difference: partially different in coordination activity (C, M vs. C) and/or interdependency (F vs. Fit)

After ensuring a reliable process for coding, I coded the remaining 10 interviews. I used Dedoose© software to code the interviews. I created a coding structure in Dedoose© based on the care coordination framework (section 3.1.1). I coded the interviews using the definitions in the coding book and the procedure described in coding instructions. Coding interviews was an iterative process; the entire coding process took 6 months.

Next, I imported all coded data into an Excel© spreadsheet. The imported data included the excerpts from the interview transcript and all of the coordination activities and interdependencies in which the excerpt was coded under. Each excerpt (care coordination activity) was a row in the spreadsheet and the columns included coordination activities and interdependencies. The content of the cells under each column was either "true" or "false" depending on coordination activities and interdependencies that existed in the excerpt (see Figure 5).

Figure 5: Example of data imported from Dedoose© to Excel© database for analysis

Document Title	Role	Excerpt Copy	Codes Applied	Code: Simultaneity	Code: Flow Applied	Code: Shared resources	Code: Monitoring	Code: Communic
Beacon FamilyMedicine CM1 PC RawC 2012 12 06.doc	OP CM	RESPONDENT: Yeah, home health is an issue, and that's why I had to work to get one of my patients who has a ton of health problems into the Medicaid system, because she was going to need hospice at some point. You can't get hospice if you're uninsured. So I had to work with her and her husband. We had to sit down and have a discussion about their finances, because she couldn't get on Medicaid, because he had a life insurance policy worth $6,000. So as it all worked out, he had to get rid of the life insurance policy and prepay for his funeral so that she could get Medicaid.	Communication, Simultaneity	True	False	False	False	True
Beacon GHP CM1 ASH TranscriptB 2012 12 5 WMA.doc	GHP CM	RESPONDENT: Trying to think from a home setting. With regard to oxygen, it's a matter, if we, we're seeing the patient in the office, and they meet the criteria for oxygen, I'm working with the home, the vendor, who's going to supply the oxygen, and telling them that I have the patient with me. We can't give the patient the oxygen for the trip home. If they need it that badly, then they need to go in an ambulance. So it's a matter of me saying to the vendor, while I have the patient sitting here, how far away do you live? When do you think you'll be home? Because then I want that vendor there as soon as possible.	Communication, Simultaneity	True	False	False	False	True
Beacon GHP CM1 ASH TranscriptB 2012 12 5 WMA.doc	GHP CM	I'm on the cell phone outside of the meeting, trying to do that, understanding at what time that all [medication dose change] needs to take place. RESPONDENT: Yes. Exactly, yeah. I would have to look to see what the weight was in the morning. I would have the number on me of the particular home health nurse who's going into the home. I usually say, okay, I need her cell phone number, so I don't have to go through the agency. I make plans up front.	Simultaneity, Communication	True	False	False	False	True
Beacon GHP CM1 ASH TranscriptB 2012 12 5 WMA.doc	GHP CM	I was using my coworker's phone or my cell phone to get in contact with the nursing home people to say, can you take the patient? I was IMing the case manager at Geisinger Health Plan, who provides authorization for the direct admits, and just juggled it all to, you know, simultaneously.	Simultaneity, Communication, Facilitator	True	False	False	False	True
BeaconSUNHH1 ASHRawB2012 12 5 WMA.doc	HH	And, you know, depending on what the patient is being referred for, you know, if it's a patient who's on IV antibiotics, and the IV is due at a certain time, you know, we have to know, number one, you know, what time they're going to be home, what time the drug is due, and has the infusion company delivered the medication and all the supplies to the home? Because it doesn't do any good if we're there at 5:00, the patient is there at 5:00, and we don't have the drug or the supplies. So, you know, that . . . INTERVIEWER 1: Who does that coordinating to make sure that the infusion services has everything there. RESPONDENT: It would be the discharge planner in the hospital who would set that up.	Communication, Simultaneity	True	False	False	False	True
Beacon FamilyMedicine CM1 PC RawC 2012 12 06.doc	OP CM	I had a patient at [OP MD]'s who had frequent hospitalizations for heart failure, and he, for some reason, did not want to follow up with a nephrologist. So I actually had to work with the patient and with the doctor to make them both understand why that was important to the patient, because he needed to get on an anemia med, and the anemia was affecting his heart.	Simultaneity, Communication	True	False	False	False	True
Beacon GHP CM1 ASH TranscriptB 2012 12 5 WMA.doc	GHP CM	And I call and get them [home infusion service] onboard, give them the referral, and then they coordinate with the home health on how they're and when they're going to get in in the home. So then, of course, everybody needs to know when the patient is going to be back home and when the best time is to come. So we manage all of that, along with the family as well.	Communication, Simultaneity	True	False	False	False	True
Beacon Familymedicine CM1 ASH RawA 2012 12 06 wma.doc	OP CM	RESPONDENT: Yep. So when we're done with the patient, we meet in the back, and we kind of talk about, I have in my head what I think should be done, and he has in his head, and we kind of, pretty much, write it on a piece of paper. I have papers, and I write up a plan. Then we go over the plan together, really quickly, or we have the patient come back in or whatever. It all depends on the acuteness of the problem.	Communication, Simultaneity	True	False	False	False	True

I used Excel© filters to determine the number of activities for categories of communication, monitoring and the different interdependencies. This analysis produced the number of activities for each combination of coordination activity and interdependency (e.g., communication-flow).

To further understand the nature of care coordination activities, I performed a deeper analysis to create sub-categories of these activities using constant comparison method (Boeije, 2002). Performing the constant comparison analysis involved six steps:

1) Reading excerpts for each care coordination activity: I read excerpts of care coordination activities from interviews that I had extracted to an Excel© spreadsheet.
2) Summarizing the care coordination activities: I summarized each excerpt of care coordination activity in a separate column in the spreadsheet.
3) Creating paper artifacts that included the summary of activities: I printed the summaries for 11 activities involving communication-simultaneity, 13 activities involving monitoring-flow and 27 activities involving communication-flow and shared resources. These combinations of coordination activities and interdependencies were to account for the different categories of care coordination activities. My advisor and I used these paper artifacts to independently analyze these data.
4) Taking marginal notes on the paper artifacts: My advisor and I separately reviewed the care coordination activities on each paper artifact and took marginal notes about the nature of the activity (see Figure 6).

5) Creating initial sub-categories for care coordination activities: We compared our marginal notes for the activities and started grouping those with similar nature; this process provided us with an initial list of sub-categories for care coordination activities.
6) Refining the list of sub-categories as more data were analyzed: I continued to analyze the remaining combinations of care coordination activities and interdependencies, and refined the list of sub-categories (see Figure 6). I discussed my updated lists with my advisor until we reached consensus on a final list of sub-categories.

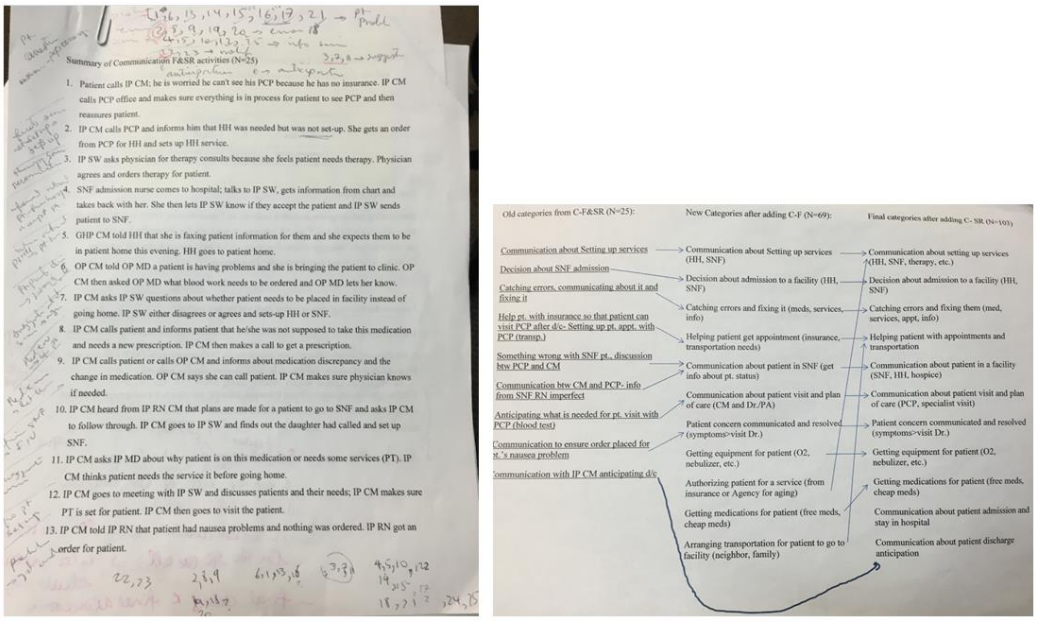


Figure 6: Paper artifacts created and used during sub-categorization of care coordination activities

The focus of data analysis for RQ1 is on identifying care coordination activities using the process described above. As described in section 3.1.2, I also identified barriers and facilitators and good or poor coordination outcomes associated with care coordination activities using the SEIPS model (Carayon et al., 2006, 2014). I created coding structures in Dedoose© for "barriers" and "facilitators" and "good" and "poor" coordination. As I read the interview

transcripts, I identified work system barriers and facilitators associated with care coordination activities. Work system barriers and facilitators are factors in the immediate work setting of the care coordination team that support or hinder their ability to optimally perform their job (Carayon et al., 2005). I also coded good and bad coordination when I was able to link a care coordination activity to good or poor coordination outcomes. As described in section 4.3.2.1, as part of the interviews, we asked participants to give us examples of good or bad coordination; this helped me to link care coordination activities to outcomes.

The qualitative data analysis was an iterative process. At each of the stages described above, my advisor reviewed my work and provided feedback, and I revised my work based on her feedback. I kept a diary in a Word document of all data analysis activities that I performed, questions that I had and decisions that we made in meetings with my advisor. The diary helped me to keep track of all the data analysis steps. See Appendix 7 for an example of my diary.

4.4 Quality criteria for RQ1

To ensure quality of qualitative research, I used four criteria: credibility, transferability, dependability and conformability (Creswell, 2009; Devers, 1999). Table 12 shows the definitions of each quality criteria and strategies I used to ensure my research met those criteria for RQ1.

Table 12: Quality of qualitative research

Quality Criteria	Definition of the criteria	Strategies to address the criteria for RQ1
Credibility/ Internal validity	"The 'truth' of the findings, as viewed through the eyes of those being observed or interviewed and within the context in which the research is carried out" (Devers, 1999, p. 1165).	-Development of a conceptual framework for coding (Patton, 1999): my advisor and I developed a conceptual framework for care coordination activities through an iterative process. I used her feedback to make changes to the conceptual framework. -I kept track of changes in the conceptual framework in a research diary (Saldana, 2009). - I used direct quotes from interviews in presenting results. - All interview data are available for other researchers.
Transferability/ External validity	"The extent to which findings can be transferred to other settings" (Devers, 1999, p. 1165).	- Detailed description of the context (Devers, 1999): I described the setting of the project and characteristics of the participants (section 4.2). -I used the SEIPS model (Carayon, 2006) to describe the context (work system barriers and facilitators). - Data were collected at different healthcare organizations and included a variety of care coordination team members.
Dependability/ Reliability	"The extent to which the research would produce similar or consistent findings if carried out as described, including taking into account any factors that may have affected the research results" (Devers, 1999, p. 1165).	- Data archiving/creating an audit trail (Devers, 1999): I kept a research diary and included information about different steps of conceptual framework development and data analysis; including all decisions made during meetings with my advisor. -A detailed coding book was created for data analysis (Appendix 5). -I used an interview guide and two interviewers were present to ensure all questions were asked (Appendices 4A-4D). -Inter-rater reliability assessment of interview coding for RQ1. The first interview coding did not have a satisfactory (52%) agreement rate, but the second interview resulted in 83% agreement (Section 4.3.1.1).
Confirmability/ Objectivity	Providing evidence from participants and research context that confirms the findings (Devers, 1999).	-Skeptical peer review (Devers, 1999): all of the research stages including conceptualization of research question, data collection, data analysis and results were discussed with my advisor. I used my advisor's feedback to make changes. I also presented my research proposal to my committee members and used their feedback for data analysis and presentation of results. -I used attentive-listening research probes (Zeisel, 1984) to confirm information by participants.

4.5 Methods for Research Question 2

For the second research question, I performed a secondary data analysis of interviews conducted with care managers and other healthcare professionals in the Keystone Beacon project. As mentioned in section 3.2, care managers are the "communication hub" for the care coordination team of chronically ill patients. Communication activities between the care coordination team members can be identified from interviews of care managers as they explain their interactions with other team members; specifically interactions during patient transitions to different care settings. As mentioned in section 2.2, coordinating care during transitions is a challenge, and care coordination interventions should focus on the communication during these transitions. For the purpose of the second research question, I focus on communication that occurs between care coordination team members to notify one another of patient admission, discharge, transfer or ED visits; this is a major instance of patient care coordination.

4.5.1 Sample

We recruited Keystone Beacon care managers and other healthcare professionals involved in care coordination of Keystone Beacon patients.

4.5.1.1 Care managers

We collected a total of 41 interviews during 7 periods of data collection over 21 months. The interviews were conducted with 15 participants: 5 inpatient care managers, 3 outpatient care managers, 5 TOC care managers and 2 float care managers (see Table 13).

Table 13: Keystone Beacon care managers recruited for RQ2

Care coordination member category	Title	# of participants	# of interviews
Discharge planner/ care managers	Inpatient care manager	5	19
	TOC care manager	5	11
	Outpatient care manager	3	7
	Float care manager	2	4
	Total	15	41

Care managers were recruited for the study because they had a major role in care coordination of Keystone Beacon patients (i.e. patients with CHF and COPD). Purposeful sampling (Creswell, 2009; Robson, 2011) was used to select participants based on the following criteria:

1) Be a Keystone Beacon care manager

2) Work at Keystone Beacon facilities (hospitals, clinics and nursing homes)

3) Be available during the data collection period.

4.5.1.2 Other healthcare professionals

In addition to care managers, we conducted 19 interviews with 18 (a physician was interviewed twice) other healthcare professionals involved in care coordination (see Table 14).

Table 14: Other healthcare professionals recruited for RQ1

Care coordination member category	Title	# of participants	# of interviews
Physicians	Primary Care Physicians (PCP)	3	4
Nursing	Staff nurse	1	1
	Nurse at nursing home	1	1
	Nurse manager at nursing home	1	1
	Nurse manager at primary care clinic	1	1
	LPN at primary care clinic	1	1
Discharge planners/ case managers	Inpatient case managers	3	3
	Social worker at nursing home	1	1
	Social worker at hospital	1	1
Administrators	Director of case management at hospital	1	1
	VP of nursing administration at hospital	1	1
	Director of social services at nursing home	1	1
	Director of social work at hospital	1	1
	Chief compliance officer at hospital	1	1
	Total	18	19

The healthcare professionals listed in Table 14 were recruited because they interacted with Keystone Beacon care managers and were involved in care coordination of Keystone Beacon patients during transitions across care settings. These healthcare professionals were not hired specifically by the Keystone Beacon project; they worked at participating healthcare organizations.

Purposeful sampling (Creswell, 2009; Robson, 2011) was used to select participants based on the following criteria:

1) Be among the 7 categories of members of the care coordination team (Kianfar et al. 2013) mentioned in section 2.3.2. The 7 categories are listed below. For this study, we were able to recruit participants from 4 categories, which are listed in parentheses. See Table 14 for details.

a. Patients and families
b. Physicians (3 participants)
c. Nurses (5 participants)
d. Discharge planners/care managers (5 participants)
e. Ancillary providers
f. Home services
g. Other (5 participant: administrators)

2) Work at facilities participating in the Keystone Beacon project (hospitals, clinics and nursing homes).
3) Interact with Keystone Beacon care managers regarding Keystone Beacon patients.
4) Be available during the data collection period.

4.5.2 Data collection

The second research question focuses on how healthcare professionals involved in care of chronically ill patients communicate to coordinate care. To answer this research question, I used interviews of Keystone Beacon care managers and other healthcare professionals who interact with Keystone Beacon care managers and are involved in care coordination of Keystone Beacon patients.

As discussed in sections 2.1 and 2.2, transitions between care settings are critical for patients and care coordination is key for safe transitions. I focused on communication that occurs between members of care coordination team, including care managers and other healthcare professionals,

who are responsible for coordinating care during patient transitions, i.e. admission, discharge or transfer.

4.5.2.1 Care manager data

As mentioned earlier, care managers have a major role in care coordination and they communicate with other healthcare professionals to coordinate care. I used findings of a previous analysis of care manager interviews aimed to identify communication instances in which a care manager or another healthcare professional was notified about patient admission, discharge, transfer or ED visit. I performed a secondary analysis of the communication events to further analyze the communication that occurs for coordinating patient care during an admission, discharge, transfer or ED visit.

We conducted care manager interviews during 7 data collection periods. Each care manager was interviewed on 1-6 occasions. The main purpose of the interviews was to understand the work of care managers and their interactions with other members of the care coordination team.

4.5.2.1 Data from other healthcare professionals

We conducted interviews with physicians, nurses, care managers, social workers and administrators who interacted with Keystone Beacon care managers about Keystone Beacon patients. The main purpose of the interviews was to understand their interactions with care managers and other members of the care coordination team. I performed a secondary analysis of these interviews to analyze the communication that occurs for coordinating patient care during

admission, discharge, transfer or ED visit. I used these interviews to get the perspective of other members of care coordination team about communication that occurs for coordinating patient care during transitions.

4.5.3 Data collection procedures

IRB approval was obtained from participating healthcare organizations and the researchers' academic institution. Participants were recruited via email. Participation in the interviews was voluntary. Participants' schedules and their physical location were taken into account when organizing the interviews. Two interviewers from our research team were present for each interview; one person was responsible for asking questions and the other person was responsible for audio recording, taking notes and keeping track of questions asked. Interviews were audio-recorded after asking for consent from participants. All interviews were transcribed by a professional transcription service. The average duration of care manager interviews was 1 hour and 30 minutes (min: 40 minutes; max: 3 hours and 20 minutes). The total duration for the 41 care manager interviews was 62 hours and 49 minutes. The average duration of interviews with other healthcare professionals was 32 minutes (min: 15 minutes; max: 1 hour). The total duration for the 19 interviews with other healthcare professionals was 10 hours and 12 minutes. The total duration for all 60 interviews was 73 hours and 1 minute.

4.5.4 Data analysis

As described in section 3.2, to answer the second research question, communication activities that contributed to notification of hospital admission, discharge, transfer (between hospitals) and

ED visit were identified and analyzed based on the communication framework by Lingard et al. (2004).

As mentioned earlier, the initial analysis of the care manager interviews was intended to capture instances in which a care manager or another healthcare professional was notified about a Keystone Beacon patient's care transition. For the secondary data analysis of the 41 care manager interviews, I used the data that were previously analyzed, which included an Excel© spreadsheet with excerpts of care transition notifications and a series of variables (columns in Excel©) such as sender, receiver and medium. I created a coding book to describe the conceptual framework by Lingard et al., (2004) that I used for RQ2 (see section 3.2.1 and Appendix 8). I reviewed all care transition notifications that were previously analyzed in the 41 care manager interviews. I reviewed the care manager interview transcripts to double check each communication event and made changes based on the objective of my data analysis and the conceptual framework. For example, the previously analyzed data included instances in which care managers got notified about patient transition by reviewing the electronic record; I removed these instances because they did not involve communication. In addition, senders and receivers were not suitable for my purpose, because communication events about coordination could involve multiple people. Therefore, people involved, was a better choice and fit with my conceptual framework. This step allowed me to verify the previously analyzed data and correct errors. The final Excel© spreadsheet included communication events in rows and different communication variables as columns: content, medium, people involved and purpose (see Figure 7).

Quote	Content	Medium	People involved	Purpose
INTERVIEWER 1: So and you talk with your case managers, for example, so you say you call. I mean, you actually mean calling or is it also putting, I was going to say putting stuff in Epic but you don't do that, do you still use IM, instant messaging RESPONDENT: IM some, yeah. They usually get, if it's only to find out, if they just want to know somebody is still here, they'll IM me and just ask if the patient is still here, stuff like that.	The IP CM says that OP CMs will IM her to see if the patient is still in the hospital (not discharged yet)	IM	OP CM, IP CM	Patient discharge

Figure 7: Example of a communication event and associated elements

For the 19 interviews with other healthcare professionals, I used qualitative content analysis (Graneheim & Lundman, 2004) to code communication events that occurred during patient transitions. First, I reviewed the interview transcripts and identified communication events in which healthcare professionals notified one another of patient admission, discharge, transfer and ED visit. Then, I created an Excel© spreadsheet and entered the excerpts from the interviews related to communication events. In the third step, I used the coding book to code the communication events based on Lingard et al. (2004) framework and identified content, medium, people involved and purpose for each communication event. In the fourth step, I combined all of the data in the two Excel© spreadsheets from care managers and other healthcare professionals. I transferred the data to SPSS© and performed descriptive statistical analysis on the four variables for each transition type: admission, discharge, transfer and ED visit. I also performed cross-tabulation on different pairs of variables to understand their relationships.

4.6 Quality criteria for RQ2

To ensure quality of the qualitative coding of communication events, I used four criteria: credibility, transferability, dependability and conformability (Creswell, 2009; Devers, 1999).

Table 15 shows the definitions of each quality criteria and strategies I used to ensure my research met those criteria for RQ2.

Table 15: Quality of qualitative research

Quality Criteria	Definition of the criteria	Strategies to address the criteria for RQ2
Credibility/ Internal validity	"The 'truth' of the findings, as viewed through the eyes of those being observed or interviewed and within the context in which the research is carried out" (Devers, 1999, p. 1165).	-I used the conceptual framework by Lingard et al., (2004) to study communication events in context of a team of healthcare professionals. - All interview data are available for other researchers.
Transferability/ External validity	"The extent to which findings can be transferred to other settings" (Devers, 1999, p. 1165).	- Detailed description of the context (Devers, 1999): I described the setting of the project and characteristics of the participants (section 4.2). - The data were collected at different healthcare organizations and included a variety of participants.
Dependability/ Reliability	"The extent to which the research would produce similar or consistent findings if carried out as described, including taking into account any factors that may have affected the research results" (Devers, 1999, p. 1165).	- Data archiving/creating an audit trail (Devers, 1999): I kept a research diary and included information about different steps of data analysis; including the process to verify previously analyzed data and all decisions made during meetings with my advisor. -A detailed coding book was created for data analysis (Appendix 8). -I verified all of the instances of admission, discharge, transfer and ED visit that were previously analyzed by going back to the 41 care manager interview transcripts, and asking questions to researchers involved in the previous analysis; I made changes when needed.
Confirmability/ Objectivity	Providing evidence from participants and research context that confirms the findings (Devers, 1999).	-Skeptical peer review (Devers, 1999): all of the research stages including conceptualization of research question, use of secondary data, data analysis and results were discussed with my advisor. I used my advisor's feedback to make changes. I also presented my research proposal to my committee members and used their feedback for data analysis and presentation of results.

Chapter 5: Results

I present the results of my research in form of two manuscripts: one for RQ1 and one for RQ2. I plan to submit the first manuscript to a human factors journal and the second manuscript to an informatics journal. The manuscripts in this chapter are drafts and I will further revise them before submission. Detailed results for RQ1 and RQ2 are provided in Appendices 9 and 10.

Manuscript 1: Care coordination activities performed for chronically ill patients

Abstract: Care coordination is important for chronically ill patients who need assistance from a variety of healthcare professionals especially when they transition through different care settings. This paper provides a two-dimension framework of care coordination for chronically ill patients: 1) coordination activities and 2) interdependencies. We used this framework to perform a qualitative content analysis of 12 interviews with healthcare professionals involved in coordinating care of chronically ill patients. We identified a total of 258 care coordination activities and developed categories and sub-categories using the constant comparative method. The first category of care coordination activities involves communication with flow or shared resources interdependencies or both. This category includes arranging services and equipment for patient, exchanging information about patient transition to different care settings, reporting errors and resolving them, and helping patient with appointment and transportation. The second category involves monitoring or communication and monitoring with flow or shared resources interdependencies or both. This category includes reviewing medications and services and detecting errors, reviewing patient symptoms and following up if needed, and scheduling follow-up to review patient status. The last category involves communication with simultaneity interdependency. This category involves talking in the same location and developing a plan of care, different people exchanging information at the same time, and scheduling delivery of medications/services at time of patient arrival home.

Keywords: Care coordination, coordination activity, interdependency, chronically ill patients

1. Introduction

Chronically ill patients constitute about half of the US adult population (Ward et al., 2014) and represent more than 80% of healthcare costs (Anderson, 2010). Chronic illnesses are among the major causes of death (Murphy et al., 2013). Congestive Heart Failure (CHF) and Chronic Obstructive Pulmonary Disease (COPD) are two common chronic illnesses. CHF is the most common cause of hospitalization among the elderly in the US (Coffey et al., 2012; Hollenberg & Heitner, 2012; Takeda et al., 2012). COPD is the "fourth leading cause of morbidity and mortality in the US" (Pauwels et al., 2001, p. 1257). Chronically ill patients need assistance from a variety of healthcare professionals to manage their condition (Bodenheimer, 2008). These patients often transition through different care settings such as hospital (admission or discharge), physician office and nursing home (Bodenheimer, 2008). Unsafe transitions put chronically ill patients at risk of re-hospitalization or even death (Jencks et al., 2009). Risks of re-hospitalization and death can be reduced by improving care coordination (Jencks et al., 2009). Care coordination is, therefore, of great importance for chronically ill patients.

Care coordination involves challenges such as limited information exchange between people at different care settings and lack of follow-up care (Fagnan et al., 2011; Schoen et al., 2011; Osborn et al., 2014). Different interventions such as care management have been implemented to improve care coordination for chronically ill patients. These interventions have the potential to result in improvements in care coordination and patient outcomes (Brown et al., 2012; Hansen et al., 2011; McDonald et al., 2007). However, it is not clear what aspects of the interventions contribute to the

improvements. Therefore, there is a need for a deeper understanding of care coordination and associated activities.

2. Conceptual framework

In this paper, we use the definition of coordination by Malone & Crowston (1990, 1994): "the act of managing interdependencies between activities performed to achieve a goal" (p. 361). We developed a two-dimension framework for identifying care coordination activities:

- Dimension 1: Coordination activities: communication, monitoring
- Dimension 2: Interdependencies: flow, shared resources, simultaneity

Communication has been described as an essential coordination activity (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990; Salas et al., 2008). Communication is the exchange of information between team members to make decisions (Malone & Crowston, 1990) and plan their activities (Klein, 2001). People involved in the care of a chronically ill patient, i.e. members of the care coordination team, exchange information related to this patient.

Monitoring is another important coordination activity (Klein, 2001; Salas et al., 2008), which is about evaluating the progress of activities. Monitoring involves team members ensuring patient needs are addressed. If changes occur in the patient's situation (e.g., change in symptoms), team members should make necessary adjustments to the patient care plan and resource arrangement (Klein, 2001; McDonald et al., 2011). Monitoring activities may or may not involve

communication. For example, a care manager talks to a patient's family on a regular basis to be informed about the patient's status and inform physician about the patient (monitoring and communication). In another example, a care manager reviews a patient's chart on a regular basis to stay informed about patient status (monitoring).

Interdependencies have been described as an essential component of coordination (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990, 1994; Malone et al., 1999; Malone et al., 2003). Interdependencies are "common objects" included in different activities that determine how and in what order activities are performed (Malone & Crowston, 1990).There are three types of interdependencies (Malone & Crowston, 1990; Malone et al., 2003):

- Flow: output of an activity is used by another activity
- Shared resources: a resource is needed by more than one activity
- Simultaneity: two or more activities need to occur at the same time

The objective of this study is to use the two-dimension framework to identify care coordination activities performed for patients with CHF and COPD.

3. Methods

3.1 Study setting and sample

This study was part of a larger project on health IT-supported care management aimed at helping patients with CHF and COPD to better manage their condition and at reducing and preventing hospital admissions, readmissions and emergency department visits. In this project, care managers were assigned to inpatient and outpatient settings to coordinate care for CHF and COPD patients using various health IT applications, such as electronic health record (EHR), health information exchange (HIE) and care management documentation software (Alyousef et al., 2012).

We used purposeful sampling to choose participants that are involved in the care coordination team for CHF and COPD patients and can provide information about care coordination activities. Our sample included a total of 12 healthcare professionals: 8 care managers (3 inpatient, 5 outpatient), 1 primary care physician, 1 administrator in a home health agency, 1 social work administrator in a nursing home and 1 social work administrator in a hospital.

3.2 Data collection procedure

Institutional Review Board approval was obtained from participating healthcare organizations and the researchers' academic institution. We developed semi-structured interview guides with different scenarios involving coordination. Table 1 presents the scenarios and describes the associated interdependencies.

We asked participants to describe coordination activities that they perform in each scenario. Additionally, we asked participants about situations where coordination went well and situations where coordination did not go well. Two researchers conducted each interview at the work place of the participants. The average duration of interviews was 51 minutes (min: 32 minutes; max: 1 hour 3 minutes). The total duration for the 12 interviews was 10 hours and 11 minutes. Interviews were audio-recorded and transcribed by a professional transcription service.

Table 1: Care processes requiring coordination and examples of associated interdependencies

Care processes	Examples of interdependencies
Patient admitted to hospital and discharged home with home health (HH)	*Simultaneity interdependency* - HH provider needs to work with other home services providers, such as durable medical equipment (DME) provider to make sure patient has the right equipment when he/she gets home.
Patient admitted to hospital and discharged to nursing home (SNF)	*Shared resources* – Patient information needs to be shared between hospital and nursing home to manage patients properly
Patient visit to primary care physician (PCP)	*Flow interdependency* – Care manager monitors patient at home using phone call or telemonitoring system to ensure patient symptoms are under control.

3.3 Data coding and analysis

Two researchers (SK, PC) independently coded care coordination activities in one interview using qualitative content analysis. Comparison of the first coding showed 52% agreement on identifying coordination activities and interdependencies. The researchers discussed the differences in their coding and refined the coding book. They coded a second interview and reached 83% agreement on coding of coordination activities and interdependencies, which was a satisfactory level of agreement. The researchers discussed the differences in coding and further

refined the coding book. In the next step, one researcher (SK) coded the remaining ten interviews using Dedoose© software. Coding interviews was an iterative process that took 6 months.

All coded data were exported from Dedoose© to an Excel© spreadsheet. One researcher (SK) wrote summary notes for all care coordination activities. Then, two researchers (SK, PC) discussed the summary notes and developed categories and sub-categories for care coordination activities using the constant comparison method (Boeije, 2002). This process involved creating and using paper artifacts to write marginal notes for each summary note and identifying those with similar nature to form categories.

Three categories were identified: 1) communication with flow, shared resources or both, 2) communication/monitoring and monitoring with flow, shared resources or both, and 3) communication with simultaneity. Then, the two researchers (SK, PC) independently developed sub-categories for care coordination activities in each of the three categories using the constant comparison method (Boeije, 2002). They compared and discussed their sub-categories to reach consensus on the final list of sub-categories for care coordination activities. One researcher (SK) also coded good and poor coordination when participants had associated a care coordination activity with good or poor coordination outcomes.

4. Results

Coding of the 12 interviews resulted in a total of 258 care coordination activities. Of the 258 activities identified, 202 (78%) involved communication, 13 (5%) involved monitoring and 43 (17%) involved both communication and monitoring. A total of 100 (39%) activities involved flow interdependency, 112 (43%) activities involved shared resources interdependency, 35 (14%) activities involved both flow and shared resources interdependencies, and 11 (4%) activities involved simultaneity interdependency. See Table 2 for details.

Table 2: Care coordination activities and interdependencies

Activities	Interdependencies				
	F	SR	F&SR	S	Total
Communication	67 (11)	103 (12)	21 (8)	11 (4)	202 (12)
Monitoring	13 (7)	0	0	0	13 (7)
Communication & Monitoring	20 (10)	9 (5)	14 (5)	0	43 (12)
Total	100 (12)	112 (12)	35 (10)	11 (4)	258 (12)

Note: numbers in parenthesis represent the number of interviews in which the care coordination activities were mentioned; there were a total of 12 interviews. F= Flow, SR=Shared Resources, S=Simultaneity.

Qualitative content analysis of the 258 care coordination activities resulted in categories and sub-categories of care coordination activities (see Table 3).

Table 3: Categories and sub-categories of care coordination activities

Categories	Sub-categories			F	F&SR	SR	Total
Communication F, SR, F&SR	Arranging services for patient			25	3	15	43
	Exchanging information about errors and resolving them			3	6	17	26
	Exchanging information about discharge anticipation				1	19	20
	Exchanging information about patient admission and hospital stay					16	16
	Exchanging information about patient medications			13		2	15
	Exchanging information about patient in a facility			1	3	11	15
	Exchanging information about patient visit and plan of care			5		9	14
	Reporting patient symptoms and resolving them			9	2	2	13
	Arranging equipment for patient			5		7	12
	Deciding about patient admission to a facility			3	4	4	11
	Helping patients with appointment and transportation			3	2	1	6
	Total			67	21	103	191
Monitoring/ Communication & Monitoring F, SR, F&SR		M	C&M				
	Reviewing medications and services and detecting errors	7	30	19	12	6	37
	Reviewing patient symptoms and following up if needed	3	13	11	2	3	16
	Scheduling follow-up to review patient status	3		3			3
	Total	13	43	33	14	9	56
Communication S	Talking in the same location and developing a plan of care						5
	Exchanging information between different people at the same time						3
	Scheduling delivery of medication/services at time of patient arrival home						3
	Total						11
Total				100	35	112	258

Note: Colors in Table 3 correspond to those in Table 2. F= Flow, SR=Shared Resources, S=Simultaneity.

4.1 Communication F, SR, F&SR

1) Arranging services for patient (N=43):

Healthcare professionals communicate with each other and patients/families to discuss patients' needs for services. Then, they get authorization for patients to receive the services and they set up those services. For example, care managers and social workers get authorization for patients from insurance companies or aging agencies to get services. *"Our social workers and case managers, depending on the insurance, are calling the insurance company and getting the authorization for that stay at the nursing home" (IP SW).* In another example, hospital care managers and social workers talk about patients' needs for services and how they make sure those services are set up for the patients. If they think a specific service is needed for a patient, they may talk to the physician about it. *"Social workers get involved with asking for therapy consults from the physicians. So especially for those patients who might, we are, happen to be debilitated or, you know, not looking as strong as we think they really need to be to be able to go home. And often, the physicians will order that" (IP SW).*

2) Exchanging information about errors and resolving them (N=26):

Healthcare professionals identify and report errors regarding medications, services and other aspects of patients' plan of care (e.g., appointments) to other healthcare professionals and patients. They then attempt to resolve those discrepancies. For example, a TOC CM calls an inpatient physician to express concern about a patient's lab results and asks for what they should do next. *"I'll call the attending physician myself and say, you know, I'm really concerned about this patient's blood sugars. It doesn't appear that anybody is doing anything to correct them. They're all over the place. What are we doing?" (TOC CM).*

3) Exchanging information about discharge anticipation (N=20):

Healthcare professionals talk about patients' needs in preparation for discharge. For example, an IP CM informs an OP CM about a patient's diet and medication-taking habits right before the patient is discharged. *"If they don't seem to understand things about their diet or don't seem to be willing to do those things, I'll let the case manager know this was an issue in the hospital. And they told us that they weren't taking their medications, but she thought that they were. You know, those types of things I pass on to them" (IP CM).*

4) Exchanging information about patient admission and hospital stay (N=16):

Healthcare professionals and patients/families inform each other about patients' admission to hospital and exchange information about patients' hospital stay. For example, an IP CM informs GHP CMs that a patient is in the hospital and provides information about the patient. *"I'll send a message to both of medical home care managers saying patient admitted to the hospital, COPD. Going to be new to either one of you. This is what I saw. This is what's going on. This is what needs to be done. And I'll forward it to them" (IP CM).*

5) Exchanging information about patient medications (N=15):

Healthcare professionals communicate with each other to arrange medications for patients, including affordable and free medications. For example, an IP CM collects a patient's information and contacts pharmaceutical companies to apply for assistance program to get free medications for the patient. *"When we find patients who are having medication issues, that can't afford their meds and stuff, the case managers are calling a drug company, filling out paperwork for an application for their assistance program, collecting, sometimes, financial information*

from patients and families to be able to complete those applications and that kind of thing" (IP SW).

6) Exchanging information about patient in a facility (N=15):

Healthcare professionals exchange information about a patient who is in nursing home or hospice or is receiving home health services. PCP makes a visit to the facility if needed to get a clear understanding of the patient's status. Healthcare professionals in the facility contact PCP if there are issues with the patient. For example, a TOC CM contacts a nursing home to inquire about a patient. *"A lot of times I'll call the supervising nurse at the facility, to gather more information from them. I'm not getting a clear picture of what's going on with the patient, and could you please, you know, gather the information for me, and this is what I need" (TOC CM).*

7) Exchanging information about patient visit and plan of care (N=14):

Healthcare professionals exchange information about patients' clinic visit and plan of care with each other and with patients/families. For example, a PCP asks a specialist about a patient's visit, especially when the patient is not able to provide information about the visit. *"Sometimes, yeah. I'll come out to the office and ask (specialists), especially if somebody is really sick, and they, and the patient can't tell me, well, they've made a change on, and if somebody has been following with them, then, yes, I will step out and reach out to their specialist, who's, you know, managing their care" (OP physician).*

8) Reporting patient symptoms and resolving them (N=13):

Care managers become aware of patients' problems and inform physicians to resolve the problems. For example, a patient calls a TOC CM to inform her of a problem; the TOC CM then

facilitates getting an appointment for the patient to come to the clinic. *"Well, they do call me if they're on my caseload. I sometimes get a call from my patients, or I'm calling them, so I might find out I'm not feeling well. I'm, you know, I'm having these symptoms. I've been coughing a lot. And then I would facilitate getting them an appointment based on their symptoms and how acute they were. I would go out and talk to the desk clerk, talk to the director" (TOC CM)*.

9) Arranging equipment for patient (N=12):

Healthcare professionals exchange information about patients' need for equipment, get the equipment ordered for patients and inform patients about insurance requirements for the equipment. For example, a therapist informs a SNF SW about a patient's need for a walker. *"When the therapists come back, they come back, and they do a report. They give me a copy, the family a copy, the resident a copy, and then on there is recommendations. You know, they have this, this, and this, but they're still going to need, a walker" (SNF SW).*

10) Decision about patient admission to a facility (N=11):

Healthcare professionals exchange information about patients' needs for going to a facility (e.g., nursing home, hospice) and make a decision about it. For example, a SNF nurse comes to a hospital to talk to IP SWs and gather patient information. The SNF nurse later informs IP SWs about decision to admit the patient and IP SWs send the patient to the nursing home. *"(Nursing home admission nurse) will come see the social workers, talk to the social workers, pick up the chart, get what they need from the chart, take it back, let us know if they can accept the patient, and then when we send the patient" (IP SW)*.

11) Helping patients with appointment and transportation (N=6):

Care managers help patients get appointments with their PCP while accommodating their transportation limitations. Care managers also arrange transportation for patients to go to a facility when needed. For example, an OP CM finds someone in the community who can drive the patient to a facility; the nurse in the facility can then welcome the patient to the facility. *"Generally, it's just trying to find somebody in the community who would be willing to get them in a car and get them. If we can get them to the facility, the nurses will come out and get them in a wheelchair and get them in there, I think" (OP CM).*

4.2 Monitoring/Communication & Monitoring F, SR, F&SR

1) Reviewing medications and services and detecting errors (N=37):

Healthcare professionals review patient medications and services; if they find errors, they take follow-up action to correct the error. For example, when a patient leaves a facility, a GHP CM ensures services needed by patient are set up correctly. *"My job is to then, after they [patients]'re out [from facility], follow up and make sure all of those services got in place. And if they didn't, then I have to pick up the pieces and get them in place" (GHP CM).*

2) Reviewing patient symptoms and following up if needed (N=16):

Healthcare professionals and patients monitor patients' symptoms, such as weight, and perform follow-up actions, such as visit to a PCP. For example, a GHP CM can use telemonitoring system to know if patients are weighing themselves and to check their weight. *"We have the telemonitoring system, so in many cases, the scale is in the home, and I can tell what the weight*

is doing, or if they're not weighing themselves or, you know, the machine is not transmitting. Because I get all of those results at any time" (OP physician).

3) Scheduling follow-up to monitor patient status (N=3):

An OP CM schedules follow-ups for herself to review patients' records to stay updated with patients' status. *"So a lot of times I set follow-ups for myself just to do chart reviews to see, is there anything out there on this patient going on?" (OP CM).*

4.3 Communication S

1) Talking in the same location and developing a plan of care (N=5):

Being in the same location allows healthcare professionals and patients to communicate face-to-face, share their thoughts and develop a plan together. The simultaneous nature of these activities is due to the fact that they happen in the same location. For example, an OP CM talks to a patient and his/her family to discuss hospice service; the OP CM advises them about getting insurance for hospice. *"You can't get hospice if you're uninsured. So I had to work with her and her husband. We had to sit down and have a discussion about their finances, because she couldn't get on Medicaid… So as it all worked out, he had to get rid of the life insurance policy and prepay for his funeral so that she could get Medicaid" (OP CM).*

2) Exchanging information between different people at the same time (N=3):

Healthcare professionals use technologies such as phone, IM and conference call to exchange information synchronously. In these activities a healthcare professional needs to exchange urgent information between multiple people at the same time. For example, a patient has been

discharged home, but needs additional care. A GHP CM calls a nursing home to admit a patient and at the same time sends an instant message to an insurance care manager to authorize direct admit for the patient from home to nursing home. *"I was using my coworker's phone or my cell phone to get in contact with the nursing home people to say, can you take the patient? I was IMing the case manager at Geisinger Health Plan, who provides authorization for the direct admits, and just juggled it all to, you know, simultaneously" (GHP CM).*

3) Scheduling delivery of medications and services at the time of patient arrival to home (N=3): Healthcare professionals communicate with each other and patients/families to arrange the delivery of medications or services with respect to patient arrival time to home. For example, a HH nurse needs to know at what time a patient will be home and at what time the infusion company will deliver the medications and supplies, because they all need to happen at the same time. *"Depending on what the patient is being referred for, you know, if it's a patient who's on IV antibiotics, and the IV is due at a certain time, we have to know, number one, what time they're going to be home, what time the drug is due, and has the infusion company delivered the medication and all the supplies to the home? Because it doesn't do any good if we're there at 5:00, the patient is there at 5:00, and we don't have the drug or the supplies" (HH).*

5. Discussion

In this study, we identified 258 care coordination activities. Categories of care coordination activities include: 1) communication with flow, shared resources or both, 2) monitoring or communication and monitoring with flow, shared resources or both, 3) communication with simultaneity. In each of these three categories, we identified sub-categories of care coordination

activities. The first category includes eleven sub-categories, including arranging services and equipment for patient, exchanging information about patient transition to different care settings, reporting errors and resolving them, and helping patient with appointment and transportation. The second category includes three sub-categories, including reviewing medications and services and detecting errors, reviewing patient symptoms and following up if needed, and scheduling follow-up to review patient status. The last category has three sub-categories, including talking in the same location and developing a plan of care, different people exchanging information at the same time, and scheduling delivery of medications/services at time of patient arrival home.

All eleven activities in the category of communication with flow, shared resources or both are consistent with previous research on coordination. Arranging services for patients, exchanging information about patient medication, deciding about patient admission to a facility, and helping patients with appointment and transportation were identified by Maliski et al. (2004), McDonald et al. (2011) and Oliva (2010). Exchanging information about patient visit and plan of care and arranging equipment for patients were identified by Maliski et al. (2004) and McDonald et al. (2011). Reporting patient symptoms and resolving them were mentioned by Oliva (2010) and Maliski et al. (2004). Exchanging information about errors and resolving them, exchanging information about patient transition including admission, discharge and patient in a facility, were mentioned by McDonald et al. (2011). Two of the three activities in the monitoring or communication and monitoring with flow, shared resources or both are also consistent with previous research on coordination. Reviewing medications and services and detecting errors, and reviewing patient symptoms and following up if needed were identified by Maliski et al. (2004), McDonald et al. (2011) and Oliva (2010). Scheduling follow-up to review patient status was a

unique care coordination activity identified by participants in our study. Also, all three communication with simultaneity activities we also unique to this study.

Our data showed that communication occurs in the majority (95%) of care coordination activities. These activities involve healthcare professionals in different care settings who exchange information about patient symptoms, patient medications, patient plan of care and patient admission or discharge. Communication activities also include making decisions about patient needs for services and arranging those services. These communication activities cover the entire spectrum of patient journey, which is what care coordination is about. Communication activities sometimes (16%) involve monitoring, and a small number of coordination activities (5%) include monitoring only. Monitoring without communication occurs when healthcare professionals review patient records to ensure patient medications and services are in place, or when they use telemonitoring system to ensure patient weight is under control. Therefore, although communication is a major part of coordination, coordination can still occur without communication.

Most of the care coordination activities involve shared resources (43%) or flow (39%) or both (14%) types of interdependencies. A small number (4%) of care coordination activities need to happen at the same time and involve simultaneity as an interdependency. The small number of activities involving simultaneity interdependency may indicate that care coordination activities are loosely coupled and there is less of a need for them to be performed at the same time. Flow and simultaneously interdependencies did not occur together. Flow interdependency involves

activities occurring sequentially, and simultaneity interdependency involves activities occurring at the same time. The two interdependencies, therefore, cannot co-exist.

Findings of this research show opportunity for health IT to improve care coordination by supporting communication and monitoring. Health IT should include several features to support communication across patient journey. Health IT should include a list of all of the people involved in a chronic patient's care, i.e. team members, and should provide tools that enable team members to communicate. Health IT should also include features to support monitoring of patient care. Health IT should connect to a telemonitoring system that tracks patient symptoms, such as patient weight, and alert healthcare professionals when symptoms are exacerbated. Alerts can also be embedded in health IT to inform healthcare professionals when chronic patients are due for follow-up care. Future research can focus on designing health IT to support monitoring without communication.

The significant number of care coordination activities identified (258) in 12 interviews shows the richness of our dataset. We designed the interview guide for the specific purpose of identifying care coordination activities performed by healthcare professionals who care for chronically ill patients. However, our sample did not include patients and their perspectives of care coordination. There may also have been other healthcare professionals (e.g., specialist) whose input could have enriched our research. Future research should include a wider variety of care coordination team members including patients and other healthcare professionals involved in care of chronically ill patients. We tried to address this problem using 2 strategies: 1) our

participants provided information about patients and other healthcare professionals that were involved in the care coordination activities, 2) we reached saturation for coordination activities and interdependencies. However, we did not assess saturation at the level of sub-categories of care coordination activities. It is possible that more sub-categories of care coordination activities could be added to our list if we expand the interviews to patients and others.

6. Conclusion

Coordination is important for chronically ill patients who need assistance from a variety of care professionals and often transition through different care settings. This paper provides a two-dimension framework for identifying care coordination for chronically ill patients: 1) coordination activities, 2) interdependencies. The majority of care coordination activities identified involve communication that enables healthcare professionals across different care settings to exchange information about patients, arrange resources for patients and help patients manage their condition. A small portion of coordination activities involve monitoring. Monitoring activities enable healthcare professionals to evaluate patient symptoms and ensure patient needs for medications and services are met. Findings from this study can be used to design interventions to improve communication and monitoring activities that are performed for chronically ill patients.

7. Acknowledgements

Funding for this research was provided by the US Office of the National Coordinator through the Beacon award program [award No. 90BC001301], and the CTSA program, previously through the NCRR Grant # 1UL1RR025011, and now by the NCATS Grant # 9U54TR000021.

Manuscript 2: Understanding transition notifications for chronically ill patients: Opportunities for health IT

Abstract: Transitions of care create challenges for care coordination such as lack of information exchange between different care settings. This paper focuses on communication that occurs during transitions of care for chronically ill patients, specifically those with CHF and COPD. Using a secondary analysis of 60 interviews with healthcare professionals, we identified a total of 93 communication events in which healthcare professionals notify each other about four stages of patient transition: admission, discharge, transfer or emergency department (ED) visit. Notification of patient admission and discharge is mostly done by healthcare professionals in inpatient setting to those in the outpatient setting. Notification of patient transfer is mostly among healthcare professionals in the inpatient setting. Patient ED visit notifications are mostly provided by healthcare professionals in the outpatient setting to those in the inpatient setting. Healthcare professionals frequently use phone and care management software, or talk face-to-face about transition notifications. The choice of communication media depends on the content, purpose and urgency of the communication. For example, phone is used to provide important information about the patient. Findings from this study can be used to produce health IT design requirements for improving communication between care coordination team members. For example, including features about availability of the communicator and urgency of the message.

Keywords: Communication, care coordination, care transition notification, chronically ill patients

1. Introduction

Nearly half of the US population suffers from at least one chronic illness (Ward et al., 2014). Chronic illnesses are among the major causes of death in the US (Murphy et al., 2013) and more than 80% of healthcare spending in the US is associated with chronically ill patients (Anderson, 2010). Congestive Heart Failure (CHF) and Chronic Obstructive Pulmonary Disease (COPD) are two prevalent chronic illnesses. CHF is the most prevalent cause of hospitalization for US elderly population (Coffey et al., 2012; Hollenberg & Heitner, 2012; Takeda et al., 2012). COPD is the "fourth leading cause of morbidity and mortality in the US" (Pauwels et al., 2001, p. 1257).

Chronically ill patients may go to the emergency department (ED) because their symptoms get exacerbated, they may then be admitted to the hospital and later discharged from the hospital to home or a nursing home. As these patients transition through different care settings, a variety of healthcare professionals get involved in managing their condition (Bodenheimer, 2008). Chronically ill patients may be at risk of re-hospitalization or even death if their transitions between the care settings are poorly coordinated and unsafe (Jencks et al., 2009).

Transitions of care create challenges for care coordination, such as lack of communication between healthcare professionals in different care settings (Bodenheimer, 2008; Fagnan et al., 2011; Schoen et al., 2011) and lack of an alert system for patient monitoring and follow-up (Fagnan et al., 2011). Care coordination interventions for chronically ill patients should focus on improving communication between patients and healthcare professionals during care transitions (Schoen et al. 2011, Osborn et al. 2014, Fagnan et al. 2011). Health IT has been identified as an

intervention that can improve communication between healthcare professionals across different care settings (Bates, 2015; Brennan et al., 2015; Samal et al., 2013). Designing health IT to support communication across a multidisciplinary team is, therefore, essential for coordinating care of chronically ill patients (Moran et al., 1994). Studying communication among healthcare professionals across different care settings when chronically ill patients transition through these settings can shed light on the design of health IT to support communication.

This study focuses on communication that occurs during transitions of care for chronically ill patients, specifically patients with CHF and COPD. Using an exploratory sequential mixed methods approach (Creswell & Plano Clark, 2011), we identify communication events in which healthcare professionals notify each other of patient admission, discharge, transfer or ED visit.

2. Conceptual framework

Communication is exchange of information between different people involved in coordination (i.e. team members) (Salas et al., 2008) and has been identified as an essential coordination activity (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990; Salas et al., 2008). According to Lingard et al. (2004), communication has four components: content, context, people involved and purpose. Content is the information exchanged or "what is said" (Lingard & Haber, 1999). Context is the "physical and temporal situation of an exchange" (Lingard et al., 2004, p. 331), which includes the communication medium and timing of communication. People involved refers to "composition of group engaged in communication" (Lingard et al., 2004, p. 332). Purpose refers to goals of the communication (Lingard et al., 2004, p. 331). We use the

conceptual framework by Lingard et al. (2004) to describe communication in care transition notifications.

3. Methods

3.1 Study design and sample

This study was part of a larger project on health IT-supported care management intended to improve chronic illness management for CHF and COPD patients and ultimately reduce hospital admissions, readmissions and ED visits (http://www.keystonebeaconcommunity.org). This project involved three types of care managers who coordinated care for CHF and COPD patients: 1) inpatient care managers (IP CMs) who worked at hospitals, 2) outpatient care managers (OP CMs) who worked at primary care clinics, and 3) transition of care managers (TOC CMs) who worked at a call center. Care managers used various health IT applications such as electronic health record (EHR), health information exchange (HIE) and care management documentation software (CM software) (Alyousef et al., 2012).

We analyzed data collected in 60 interviews with care managers and other healthcare professionals: 41 with care managers and 19 with other healthcare professionals involved in care of chronically ill patients. The 41 interviews with care managers were collected over 21 months during 7 periods of data collection with 15 participants: 5 inpatient care managers, 3 outpatient care managers, 5 TOC care managers and 2 float care managers. The 19 interviews with 18 other healthcare professionals involved in care coordination were conducted with: 3 physicians (one

physician was interviewed twice), 5 nurses, 5 discharge planners/social workers and 5 administrators.

3.2 Data collection procedure

IRB approval was obtained from participating healthcare organizations and the researchers' academic institution. Participants were recruited via email. Participation in the interviews was voluntary. Interviews were conducted in the work offices of participants. Two researchers were present for each interview; one person was responsible for asking questions and the other person was responsible for audio recording, taking notes and keeping track of questions asked. The average duration of care manager interviews was 1 hour and 30 minutes (min: 40 minutes; max: 3 hours and 20 minutes). The average duration of interviews with other healthcare professional was 32 minutes (min: 15 minutes; max: 1 hour). Total duration for all 60 interviews was 73 hours and 1 minute. Interviews were audio-recorded and transcribed by a professional transcription service.

3.4 Data analysis

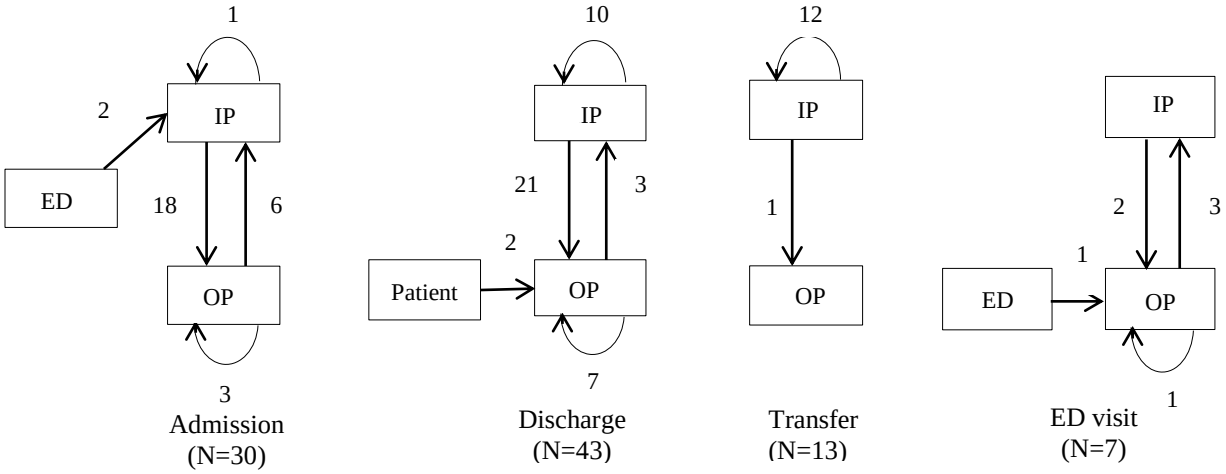
We used an exploratory sequential mixed methods approach (Carayon, Kianfar, et al., 2015; Creswell & Plano Clark, 2011). In the first step, we used qualitative content analysis (Graneheim & Lundman, 2004) to code communication events that occurred during patient admission, discharge, transfer and ED visit. An Excel© spreadsheet was created and excerpts from the interviews related to communication events were entered in the spreadsheet. A coding book was

created based on Lingard et al. (2004) framework. Content, medium, people involved and purpose were coded for each communication event. In the second step, data from the spreadsheet were transferred to SPSS© to perform descriptive statistical analysis and cross-tabulation.

4. Results

We identified a total of 93 communication events in four transition stages: 30 (32%) admissions, 43 (46%) discharges, 13 (14%) transfers and 7 (8%) ED visits. Figure 1 shows a visual representation of communication events at each of the 4 transition stages. These communication events occur between healthcare professionals in IP setting, OP setting, ED and patients at home.

Figure 1: Communication events between different settings at each transition stage



Note: The arrows represent communication events and boxes show setting of communicators. For example, an arrow from OP to IP means a healthcare professional in the OP setting notified healthcare professional in the IP setting. IP: inpatient, OP: outpatient, ED: emergency department, Patient: patient at home. Transfer refers to transfer of patients from one hospital to another hospital.

Table 1 shows a summary of different media used at each transition stage grouped into four categories. Synchronous media allows communicators to send and receive a message at the same time, which requires communicators to be available at the same time. Asynchronous media allows communicators to send and receive a message at their convenience. Combination of synchronous and asynchronous tools are used when more than a single tool is needed for a communication event. For example, email is used to provide a care transition notification and check availability of a communicator and phone is used to exchange additional patient information. Alternative tools are used for the same purpose of communication depending on the availability of those tools to the communicators. For example, if one of the communicators does not have access to IM, email is used instead.

Table 1: Media used at various transition stages

Transition stages	Synchronous			Asynchronous			Combination of tools				Alternative tools			Total
	Phone	Face-to-face	IM	CM software	EHR	Fax	CM software and Email	IM and Phone	Email and Phone	Fax and EHR	Email or IM	CM software or IM	EHR or Pager	
Admission	9	3		8	4		1	2			2	1		30
Discharge	17	12	3	6	1	1	1			1	1			43
Transfer	2	2		5					2		1		1	13
ED visit	6	1												7
Total	34	18	3	19	5	1	2	2	2	1	4	1	1	93

Note: CM software = sending FYI notice by a software used by care managers for communication and documentation. IM=instant messaging.

4.1 Admission (N=30 events)

Communication about patient admission to hospital is performed across people from different care settings including IP, OP and ED. Of the 30 communication events about patient admission, 18 (60%) are between healthcare professionals in IP to OP setting, 6 (20%) are between healthcare professionals in OP to IP setting, 3 (10%) between healthcare professionals in OP setting, 2 (7%) between healthcare professionals in ED to IP setting, and 1 (3%) between healthcare professionals from IP setting.

Communication events about patient admission between IP and OP settings are performed using different media depending on the content and purpose of the communication.

- CM software (6): is used by IP CMs to provide a simple notification to OP CMs about a patient's admission to hospital. There is a lag in notification using CM software; by the time OP CMs receive the notification, they may already be aware of patient admission. No response is expected when using CM software.
    - CM software + Email (1): IP CM uses email in addition to CM software to notify OP CM about patient admission.
    - CM software/IM (1): if an OP CM has IM set up, IM may be used instead of CM software.
- Phone (4): is used when in addition to a patient's admission notice, additional information about the patient needs to be communicated from IP to OP setting, especially if there is important or unusual information about the patient, such as a recent medication change. Also, phone provides an opportunity for people in both IP and OP settings to verbally exchange information (e.g. medication changes, doctor visits) about the patient.

- EHR (3): is used by IP CMs for notifying an OP CM about a patient's admission. Additional information such as a patient's family support and need for placement in a facility may be communicated in the message. Staff at family medicine clinic receive a report through EHR when their patients are admitted to a hospital.
- Instant Messaging (IM) is used by IP CMs to notify OP CMs about a patient's admission. IM is also used by OP CMs to ask IP CMs if their patient is in the hospital. IM allows for a quick notification and gives the opportunity to get quick a response.
    - IM+ Phone (2): IM is followed by a phone call from an IP CM to communicate additional patient information to an OP CM.
    - Email/IM (1): email can be used by an IP CM in place of IM to notify a GHP CM of patient admission.

Communication events about patient admission between OP and IP settings are performed using phone, email/IM or CM software.

- Phone (4): is used by OP CMs to notify IP CMs that a patient is coming to the hospital. OP CMs also use phone to inform IP CMs about a patient that has been admitted to the hospital, but IP CMs had missed.
- Email/IM (1): email or IM are used by TOC CMs to notify IP CMs about a patient's admission. IP CMs respond and confirm that they will follow the patient.
- CM software (1): is used by MMAs to notify IP CMs about a patient's admission along with admission date and diagnosis.

Communication events about patient admission between healthcare professionals within OP settings are performed using CM software, EHR or face-to-face.

- CM software (1): is used by MMAs to notify OP CMs about a patient's admission. The notification has a lag and OP CMs may already know about patient admission.
- EHR (1): is used by OP physician to run a list of patients admitted to the hospital for OP CM.
- Face-to-face (1): is performed when a clinic staff notifies an OP CM about a patient's admission. Being in the same office makes face-to-face communication possible.

Communication events about patient admission between ED and IP setting are performed face-to-face or using phone.

- Face-to-face (1): ED nurses notify an IP CM about a patient that will later be admitted and followed by the IP CM.
- Phone (1): is used by ED staff to notify an IP CM about a possible admission and ask the IP CM to come see a patient and figure out whether admission can be prevented. Phone enables a request in addition to the notification.

Communication event about patient admission with IP settings is performed face-to-face.

- Face-to-face (1): an IP SW notifies an IP CM about a patient's admission when she sees her.

4.2 Discharge (N=43 events)

Communication about patient discharge from hospital is performed between people from IP and OP settings and patients at home. Of the 43 communication events about patient admission, 21 (49%) are between healthcare professionals in IP to OP setting, 10 (23%) between healthcare

professionals in IP to IP setting, 7 (16%) between healthcare professionals in OP to OP setting, 3 (7%) between healthcare professionals from OP to IP setting, and 2 (5%) between patients at home to healthcare professionals in OP setting.

Communication events about patient discharge between IP and OP settings are performed using different media depending on the content and purpose of the communication.

- Phone (11): is used when, in addition to a patient's discharge notice, additional information about the patient needs to be communicated. IP CMs use phone to inform OP CMs or TOC CMs about a patient's discharge, and provide additional information about the patient (e.g., appointment, language) including anything unusual about the patient. Hospital staff use phone to inform an OP nurse about a patient's need for an appointment. Phone is also used by hospitalists to inform OP physicians about patients' discharge and any issues about the patients (e.g. social issues) that OP physicians should be aware of.
- CM software (4): is used by IP CMs to send a simple notification to OP CMs (through MMAs) about patient discharge. An IP CM also sends a message through CM software to inform a GHP CM about a patient's discharge; the IP CM assumes if the GHP CM is not assigned to that patient, he/she would still inform the right care manager.

  IM (2): is used by an IP CM to inform TOC CM about a patient's discharge and the patient's need for an appointment. An IP CM uses IM to inform an OP CM that a patient will not be discharged that day.
- Email or IM (1): an IP CM uses email or IM to inform a GHP CM about a patient's discharge to home. If there is any unusual information about the patient, then she uses phone.

- CM software + Email (1): an IP CM sends an email to inform an OP CM about a patient's discharge; the IP CM follows with a message through CM software. The reason for the initial email is that there is a lag associated with CM software.
- Fax (1): an OP physician gets discharge summary through fax from the hospital and knows a patient is discharged.
- EHR (1): a GHP CM gets notification through EHR that a patient is discharged; she then monitors the discharge instructions and follows up with the patient in 1-2 days.
- Fax and EHR (1): an OP physician gets a discharge summary from the hospital both on paper and on the computer and knows a patient is discharged.

Communication events about patient discharge within IP settings are performed face-to-face.

- Face-to-face (8): IP SWs and hospital staff tell IP CMs when anticipating a discharge; this helps IP CMs prepare. IP SWs will tell IP CMs about patients being discharged and talk about patient needs (e.g. home health).

Communication events about patient discharge within OP settings are performed face-to-face, using CM software or phone.

- Face-to-face (3): clinic staff receive discharge summary from hospital and inform OP CMs that a patient has been discharged. Being in the same office allows face-to-face communication.
- CM software (2): MMAs send CM software to OP CMs to inform them of patient discharge. There is a delay with this tool; therefore, sometimes OP CM gets the notice 2-3 days after patient has been discharged.

- Phone (2): an OP CM asks a SNF SW to inform her in advance when a patient is being discharged. A SNF SW calls an OP CM to inform her about a patient's discharge from nursing home to home. The SNF SW leaves a message if the OP CM does not pick up the phone.

Communication events about patient discharge between OP and IP settings are performed using phone or IM.

- Phone (2): a GHP CM calls an IP CM to inform her about a patient's discharge. The GHP CM knows patient is discharged before the IP CM, because hospital faxes discharge summaries to PCP offices and the IP CM was out of office in the morning and not aware of a patient's discharge. Phone conversation provides the opportunity to communicate a request in addition to discharge notification. For example, a GHP CM calls an IP CM and talks about a patient's discharge and asks IP CM to help with the patient's prescription.
- IM (1): an OP CM sends IM to an IP CM to ask if a patient is still in the hospital or discharged.

Communication events about discharge between patients at home to healthcare professionals in OP setting are performed using phone.

- Phone (2): Patients or families sometimes call an OP CM and let her know a patient has been discharged. An OP nurse knows a patient has been discharged when the patient calls to make an appointment as directed in the discharge summary; the OP nurse then makes an appointment for the patient.

4.3 Transfer (N= 13)

Communication about patient transfer to another hospital is performed among healthcare professionals in the IP and OP setting. Of the 13 communication events on patient transfer, 12 (92%) are between healthcare professionals in IP settings and 1 (8%) is between healthcare professionals in IP to OP Setting.

Communication events about patient transfer within IP settings are performed using different media depending of the content and purpose of their communication.

- CM software (4): IP CMs send CM software to other IP CMs to inform them a patient is being transferred to their hospital. FYIs can come through the MMAs.
- Face-to-face (2): an ICU nurse tells an IP CM that a patient is going to be transferred to another hospital. If a patient gets transferred to a different hospital during night or over the weekend, hospital staff tell an IP CM the day after, and then she informs the IP CM at the destination hospital.
- Email and phone (2): an IP CM emails another IP CM to inform her about a patient being transferred. In the email, she asks the IP CM to call her so she can provide more information.
- Phone (2): IP CMs call other IP CMs to inform them about a patient's transfer to their hospital.
- Email or IM (1): an IP CM sends an email or IM to inform an IP CM at another hospital that a patient is being transferred. This notification is done by IP CMs in certain hospitals, not all hospitals. IM is used when the IP CM at the destination hospital has access to IM.

- EHR message or pager (1): an IP CM sends a message through EHR or uses pager to inform an IP CM at another hospital that a patient is being transferred.

Communication event about patient transfer between IP to OP setting is performed through CM software. An IP CM sends CM software to an OP CM to inform her a patient has been transferred from one hospital to another.

4.4 ED visit (N=7)

Communication about patient visit to ED is performed between people from different care settings including IP, OP and ED. Of the 7 communication events about patient admission, 3 (43%) are from healthcare professionals in OP to IP setting, 2 (29%) from healthcare professionals in IP to OP setting, 1 (14%) between healthcare profionals in ED to OP setting, and 1 (14%) between healthcare professionals in OP setting.

Communication events about patient ED visit between OP to IP setting are performed using phone or IM.

- Phone (2): is used by clinic staff to inform an IP CM about a patient being sent to ED. Clinic staff know the IP CM so they feel comfortable calling her. Phone is also used by an OP CM to inform an IP CM about a patient being sent to ED; the OP CM asks the IP CM to see the patient. The IP CM sees the patient to possibly prevent an admission.
- Phone or IM (1): a GHP CM calls or sends an IM to an IP CM to inform her about a patient being sent to ED, and asks the IP CM to notify her if the patient gets admitted.

Phone and IM provide the opportunity to ask a request in addition to notification about patient ED visit.

Communication event about patient ED visit between IP to OP setting is performed using phone. An IP CM calls an OP CM to inform her about a patient being sent to ED. The IP CM makes this call to the OP CM after knowing the reason why patient is in ED.

Communication event about patient ED visit between ED to OP setting is performed using phone. An ED CM calls a TOC CM to inform her about a patient being in ED. The ED CM has access to CM software and can see that the patient has a TOC CM. The TOC CM mentions that this notification is a hit and miss and does not always occur.

Communication event about patient ED visit within OP setting is performed face-to-face. Clinic staff inform an OP CM about her patient being sent to ED. Being in the same location enables clinic staff and the OP CM to communicate face-to-face.

5. Discussion

In this study, we identified 93 communication events regarding notification of admission, discharge, transfer and ED visit of patients with CHF and COPD. Most of the communication events were about patient hospital admission (32%) and discharge (46%). In both admission and discharge, the majority of transition notifications were sent by healthcare professionals in IP setting to those in the OP setting (60% in admission, 49% in discharge). Notification of discharge by healthcare professionals in the IP setting helps those in the OP setting to follow up

and ensure resources are in place for the patients. Notification of admission by healthcare professionals in the IP setting can alert healthcare professionals in the OP setting to monitor patients in the hospital and anticipate their discharge. In a smaller number of care transition notifications (20% in admission, 7% in discharge), an OP CM notified an IP CM about a patient who was coming to the hospital or a patient who was being discharged. Notifications of admission by an OP CM can help an IP CM to be alert about patient admission and be sure to follow through with the patient. Notification of discharge by an OP CM can inform an IP CM who had missed a patient's discharge.

The most common media used for transition notifications are phone (36%), CM software (20%) and face-to-face (18%). Other media such as IM, email, EHR, fax and pager were used at other times. The choice of media depends on the content and purpose of the communication and also the level of urgency of the message communicated (Bates, 2015). When the purpose of communication is to send a simple notification, an asynchronous method of communication such as the CM software is used. To communicate additional information about patients, a synchronous method of communication such as phone is used. A synchronous method helps the sender to know the receiver got the message; this is particularly important when the message is critical or urgent. A synchronous method of communication requires the receiver to be available. Our data showed that an IP CM used IM to notify an OP CM about patient admission and to ask if OP CM was available for a phone call. The IP CM then used the phone to communicate additional information about the patient. The choice of media, therefore, is also limited to the capabilities of the media. Bates (2015) and Rudin and Bates (2014) suggest that level or urgency of the message and availability or interruptability of communicators need to be included in the

design of health IT. These features can make the communication about patient transitions more efficient and effective.

Our study showed that care transition notifications were generated by healthcare professionals using various media including health IT. Previous research has found that care transition notifications were performed with human involvement (Bates, 2015; Samal et al., 2013). Health IT can be used to generate automated care transition notification alerts and free the healthcare professionals from having to notify one another about patient transition; this will make the care transition notification process more efficient. Our study showed that phone was the most commonly used medium of communication regarding care transitions. Previous research found that fax and print outs were used commonly for communication about care transitions (Bates, 2015; Samal et al., 2013). Health IT has the potential to connect different care settings and automatically generate care transition notifications without the need for human involvement. Health IT should include features such as audio call and text messaging to provide both synchronous and asynchronous communication when healthcare professionals need to exchange additional information about patient transitions across care settings.

This study has several limitations. First, we used interviews collected throughout the 7 periods of data collection in the project. Not all interviews included questions about care transition notification. In the last 2 periods of data collection, we included questions about care transition notifications. It is possible that if we originally designed our data collection tool for the specific purpose of studying care transition notifications, we could have obtained richer data. Second, we

studied care transition notifications in a project with specific health IT applications. Other healthcare settings may use different health IT applications but the functionalities of these applications may be comparable to those in our study. For example, there may not be a CM software in other settings, but there may be a different software that has similar functionalities such as sending FYI notices to other healthcare professionals about patient transitions.

Findings of this study provide several opportunities for future research. First, studying care transition notifications in different healthcare settings using multiple data collection methods (e.g., interview and observations) to understand the barriers and facilitators of current media used for communicating care transition notifications. Second, linking communication events regarding care transition notifications to outcomes, i.e. percentage of notifications communicated successfully, delayed or missed. Finally, providing design requirements for health IT that enables users to communicate their message effectively based on the content, purpose urgency of their message.

6. Conclusion

Communication about patient transitions is critical for care coordination of chronically ill patients. Lack of information about patient transitions can lead to increase in patient re-admissions and ED visits. In this study, we identified 93 communication events regarding notification of admission, discharge, transfer and ED visit of patients with CHF and COPD. Notifications of patient admission and discharge are mostly provided by healthcare professionals in inpatient setting to those in the outpatient setting. Notification of patient transfer is mostly

among healthcare professionals in the inpatient setting. Patient ED visit notifications are mostly provided by healthcare professionals in the outpatient setting to those in the inpatient setting. Healthcare professionals frequently use phone and care management software, or talk face-to-face about transition notifications. The choice of communication media depends on the content, purpose and urgency of the communication. Findings from this study can be used to provide health IT design requirements for improving communication between care coordination team members.

7. Acknowledgements

Funding for this research was provided by the US Office of the National Coordinator through the Beacon award program [award No. 90BC001301], and the CTSA program, previously through the NCRR Grant # 1UL1RR025011, and now by the NCATS Grant # 9U54TR000021.

Chapter 6: Discussion and conclusion

6.1 Care coordination activities

We designed two studies to answer the two research questions intended to understand care coordination for chronically ill patients. The first study identified care coordination activities performed by healthcare professionals involved in care of chronically ill patients. The majority of these activities involved communication with flow or shared resources interdependency or both. These activities included arranging services and equipment for patients, exchanging information about patient medication and plan of care, reporting patient symptoms and resolving them, exchanging information about errors and correcting them, exchanging information about patient transitions, and helping patients with appointments and transportation. These care coordination activities are consistent with the care coordination literature (Brown et al., 2012; Maliski et al., 2004; McDonald et al., 2011; Oliva, 2010; Rudin & Bates, 2014).

A relatively small portion of care coordination activities involved monitoring with flow or shared resources interdependency or both. These activities included ensuring patient medications and services are in place, reviewing patient symptoms and following up if needed, and scheduling follow-up to review patient status. These care coordination activities are also consistent with the care coordination literature (Brown et al., 2012; Maliski et al., 2004; McDonald et al., 2011; Oliva, 2010; Rudin & Bates, 2014). Monitoring activities can occur without communication. Reviewing patient medications and services from the EHR or reviewing patient weight from telemonitoring system are examples of monitoring activities that do not include communication.

A smaller number of care coordination activities involved communication with simultaneity interdependency. The simultaneous nature of these activities made them unique. The first sub-category involves healthcare professionals who are in the same location to assess patients together and develop a plan of care together for the patient. Being in the same location allows them to be on the same page about the patient and use each other's ideas to develop to plan of care. The second sub-category involves healthcare professionals exchanging urgent information with multiple other healthcare professionals at the same time using multiple tools, such as phone and IM. In this case, urgency of information creates the necessity to perform communication activities simultaneously. The last sub-category involves scheduling delivery of medications or services at time of patient arrival home. The challenge in the last category is that home health nurse, infusion service and patient all need to arrive at the same time, otherwise coordination goes poorly.

Care coordination activities identified in the first study cover the entire spectrum of patient journey. Communication activities included exchange of information about patient admission and hospital stay, patient discharge anticipation, patient admission to a facility, and patient visit to primary care and specialist. This shows that communication during care transitions is particularly important for care coordination of chronically ill patients, and leads to the second study that focuses on care transition notifications.

6.1.1 Work system barriers and facilitators associated with care coordination activities

As part of the first study, in addition to identifying care coordination activities, we identified 85 barriers and 110 facilitators associated with care coordination activities (see Appendix 9). We did not ask questions during the interviews about all work system elements. Therefore, the barriers and facilitators may not represent all of those experienced by the participants. However, we can see how barriers and facilitators are distributed among the different work system elements. For example, health IT was mostly a facilitator because healthcare professionals appreciated having access to patient information. It is interesting to note that although participants mentioned access to patient information as a facilitator, they mentioned having to use multiple health IT applications as a barrier (Alyousef et al., 2012). Patient characteristics were mostly a barrier because some patients refused to follow recommendations of healthcare professionals such as taking medications or accepting services. Future research can develop an extensive list of barriers and facilitators associated with care coordination activities and provide possible system redesign solutions to resolve the barriers and make better use of the facilitators. Future research can also link barriers and facilitators associated with care coordination activities to good and poor coordination outcomes.

6.1.2 Good and poor outcomes associated with care coordination activities

We identified 42 (16%) activities that lead to good coordination and 28 (11%) activities that lead to poor coordination. The participants did not associate all activities with good or poor outcomes; we asked them for examples of good and poor coordination. The number of good or poor coordination outcomes identified, therefore, does not necessarily represent all possible good or

poor coordination outcomes. However, we were able to identify the nature of care coordination activities that lead to good or poor coordination. When the criteria for interdependencies are met, the activity can lead to good coordination and when the criteria are not met, the coordination can lead to poor outcomes. Care coordination activities with flow interdependency can lead to good coordination when the output of the producer activity flows to the consumer activity. For example, a TOC CM realizes a patient who was discharged from hospital to home is not doing well. She gets an order (output) from a physician for the home health agency (producer activity), and arranges home health services for the patient (consumer activity). On the other hand, care coordination activities with flow interdependencies can lead to poor coordination when the output of the producer activity does not flow to the consumer activity or when the receiver of the output decides not to proceed with the consumer activity. For example, a patient calls a PCP office with a problem. The patient does not hear back because the office staff did not transfer the call to the outpatient care manager. Future research can focus on designing health IT based on the different interdependencies to support good coordination.

6.2 Care transition notifications

The second study focused on communication regarding notification of patient admission, discharge, transfer and ED visit. In admission and discharge, the majority of transition notifications were sent by healthcare professionals in IP setting to those in the OP setting. Admission and discharge both occurred in the IP setting whose healthcare professionals then informed those in the OP setting. This information can help healthcare professionals in the OP setting to monitor their patients in the hospital or preparing for a patient who is transitioning home. In a small number of care transition notifications about admission and discharge,

healthcare professionals in the OP setting notified those in the IP setting. This information can help healthcare professionals in the IP setting anticipate an admission or be prepared for a patient discharge. Most care transition notifications about patient transfer are among healthcare professionals in the IP setting because transfer occurs between hospitals. Notifications of ED visits are mostly provided by healthcare professionals in the OP setting to those in the IP setting. This information can help healthcare professionals in the IP setting to anticipate an admission or possibly prevent an admission.

We identified the media used in care transition notifications. We found that not all healthcare professionals in our study had access to the same tools. Therefore, healthcare professionals sometimes had to use alternative tools of communication. For example, for those who did not have access to IM, healthcare professionals used email instead. Deciding which method of communication to use may need additional efforts by healthcare professionals. We also found that a single tool may not meet all the needs of healthcare professionals for communicating about a care transition. Therefore, healthcare professionals may use additional tools for a single communication event. For example, since CM software had a delay, email was used in addition to the CM software for faster notification. In another example, email was used prior to phone to check the availability of an individual for providing additional information about the patient over the phone. Use of multiple health IT applications has been identified as a barrier to care coordination (Alyousef et al., 2012). It is important to provide communication tools to care coordination team members that meet their needs.

6.2.1 Implications for health IT design to support care coordination activities

Both studies in this research show opportunity for health IT to improve care coordination. Future research can use the findings of our first study to design health IT that supports communication and monitoring by healthcare professionals in different care settings. Findings of our second study provides specific information about limitation of current tools used by healthcare professionals and the needs of healthcare professionals for specific features such as availability of the person and urgency of the message. These findings can be used to produce design requirements for health IT to support communication regarding patient transitions.

Health IT should include several features to support communication across care settings. First, health IT should include a list of all of the people involved in a chronic patient's care, i.e. team members, along with their role in patient care and their contact information. Rudin & Bates (2014) suggest using national identifiers to include team members' information in the health IT. Second, health IT should provide tools that enable team members to communicate synchronously and asynchronously. Examples of synchronous tools are instant message, audio call and video conferencing. Examples of asynchronous tools are secure messaging with attachments such as image or patient record, voicemail and video message. There should be features to show interruptability of the team members and urgency of the message; these features can help team members choose between a synchronous or asynchronous tool within the health IT. It is necessary for health IT across care settings to be interoperable.

Health IT should also include features to support monitoring of patient care. Health IT should connect to a telemonitoring system that tracks patient symptoms, such as patient weight, and alert healthcare professionals when symptoms are exacerbated. Alerts can also be embedded in health IT to inform healthcare professionals when chronic patients are due for follow-up care. Health IT should also generate alerts for care transitions including patient admission, discharge, transfer and ED visit. It is important that these alerts are sent to the appropriate healthcare professionals who would benefit from the alerts. Although health IT-generated alerts can relieve healthcare professionals from performing activities such as notification of care transitions, excessive alerts can be overwhelming and may result in alerts being ignored. Therefore, care must be taken in the design of health IT-generated alerts.

6.3 Limitations and future research

In both studies, we did not have patients as part of our sample. Although our participants talked about activities in which they interacted with patients, it is possible that we could have identified additional care coordination activities if we had interviewed patients. Also, it is possible that we could identify more care transition notifications in which patients were involved and understand the tools used by patients to notify other care coordination team members about their transition. Future research can involve patients in studying care coordination activities and communication regarding transition notification. In addition, both studies were part of a research that focused on patients with CHF and COPD. It is possible that patients with other chronic conditions may need additional care coordination activities or may use different tools for communication at care

transitions. Future research can expand on the findings of this study by focusing on other types of chronic conditions.

References

Alyousef, B., Carayon, P., Hoonakker, P., Hundt, A. S., Cartmill, R., Tomcavage, J., . . . Walker, J. (2012). Care Managers' Challenges in Using Multiple Health IT Applications. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 56*, 1748-1752.

Anderson, G. F. (2010). *Chronic Care: Making the Case for Ongoing Care*. Retrieved from Princeton, NJ:

Bates, D. W. (2015). Health Information Technology and Care Coordination: The Next Big Opportunity for Informatics? *IMIA Yearbook of Medical Informatics, 10*(1).

Bayliss, E. A., Balasubramianian, B. A., Gill, J. M., & Stange, K. C. (2014). Perspectives in Primary Care: Implementing Patient-Centered Care Coordination for Individuals with Multiple Chronic Medical Conditions. *The Annals of Family Medicine, 12*(6), 500-503.

Bodenheimer, T. (2008). Coordinating care—a perilous journey through the health care system. *New England Journal of Medicine, 358*(10), 1064-1071.

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and Quantity, 36*(4), 391-409.

Boling, P. A. (2014). Managing posthospital care transitions for older adults: Challenges and opportunities. *JAMA, 312*(13), 1303-1304.

Brennan, P. F., Valdez, R., Alexander, G., Arora, S., Bernstam, E. V., Edmunds, M., . . . Rosenbloom, T. (2015). Patient-centered care, collaboration, communication, and coordination: a report from AMIA's 2013 Policy Meeting. *J Am Med Inform Assoc, 22*(e1), e2-6.

Brown, R. S., Peikes, D., Peterson, G., Schore, J., & Razafindrakoto, C. M. (2012). Six features of Medicare coordinated care demonstration programs that cut hospital admissions of high-risk patients. *Health Affairs, 31*(6), 1156-1166.

Carayon, P. (2006). Human factors of complex sociotechnical systems. *Applied Ergonomics, 37*, 525-535.

Carayon, P., Alyousef, B., Hoonakker, P., Hundt, A. S., Cartmill, R. S., Tomcavage, J., . . . Walker, J. (2012). Challenges to care coordination posed by the use of multiple health IT applications. *Work, 41 Suppl 1*, 4468-4473.

Carayon, P., Gurses, A. P., Hundt, A. S., Ayoub, P., & Alvarado, C. J. (2005). Performance obstacles and facilitators of healthcare providers. In C. Korunka & P. Hoffmann (Eds.), *Change and quality in human service work*. Munich: Hampp Publishers.

Carayon, P., Hundt, A. S., Hoonakker, P., Kianfar, S., Alyousef, B., Salek, D., . . . Tomcavage, J. (2015). Perceived impact of care managers' work on patient and clinician outcomes. *European Journal for Person Centered Healthcare, 3*(2), 158-167.

Carayon, P., Hundt, A. S., Karsh, B.-T., Gurses, A. P., Alvarado, C. J., Smith, M., & Brennan, P. F. (2006). Work system design for patient safety: the SEIPS model. *Quality and Safety in Health Care, 15*(suppl 1), i50-i58.

Carayon, P., Kianfar, S., Li, Y., Xie, A., Alyousef, B., & Wooldridge, A. (2015). A systematic review of mixed methods research on human factors and ergonomics in health care. *Applied Ergonomics, 51*, 291-321.

Carayon, P., Wetterneck, T. B., Rivera-Rodriguez, A. J., Hundt, A. S., Hoonakker, P., Holden, R., & Gurses, A. P. (2014). Human factors systems approach to healthcare quality and patient safety. *Applied Ergonomics, 45*(1), 14-25.

Coffey, R. M., Misra, A., Barrett, M., Andrews, R. M., Mutter, R., & Moy, E. (2012). Congestive heart failure: Who is likely to be readmitted? *Medical Care Research and Review*.

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*: Sage publications.

Crabtree, B. F., Nutting, P. A., Miller, W. L., Stange, K. C., Stewart, E. E., & Jaén, C. R. (2010). Summary of the National Demonstration Project and recommendations for the patient-centered medical home. *The Annals of Family Medicine, 8*(Suppl 1), S80-S90.

Creswell, J. W. (2009). *Research Design - Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Methods Research*. Los Angeles, CA: Sage Publications.

Devers, K. J. (1999). How will we know" good" qualitative research when we see it? Beginning the dialogue in health services research. *Health Services Research, 34*(5 Pt 2), 1153.

Edelman, N. H., Kaplan, R. M., Buist, A. S., Cohen, A. B., Hoffman, L. A., Kleinhenz, M. E., . . . Speizer, F. E. (1992). Chronic obstructive pulmonary disease. *Chest, 102*(3 Supplement), 243S-256S.

Effken, J. A., & Abbott, P. (2009). Health IT-enabled Care for Underserved Rural Populations: The Role of Nursing. *Journal of the American Medical Informatics Association : JAMIA, 16*(4), 439-445.

Fagnan, L. J., Dorr, D. A., Davis, M., McGinnis, P., Mahler, J., King, M. M. C., & Michaels, L. A. (2011). Turning on the care coordination switch in rural primary care: voices from the practices—clinician champions, clinician partners, administrators, and nurse care managers. *The Journal of Ambulatory Care Management, 34*(3), 304.

Fan, V. S., Gaziano, J. M., Lew, R., Bourbeau, J., Adams, S. G., Leatherman, S., . . . Liang, M. H. (2012). A comprehensive care management program to prevent chronic obstructive pulmonary disease hospitalizations. *Annals of Internal Medicine, 156*(10), 673-235.

Gilfillan, R. J., Tomcavage, J., Rosenthal, M. B., Davis, D. E., Graham, J., Roy, J. A., . . . Steele, G. D., Jr. (2010). Value and the medical home: Effects of transformed primary care. *American Journal of Managed Care, 16*(8), 607-a615.

Gittell, J. H. (2000). Organizing work to support relational co-ordination. *The International Journal of Human Resource Management, 11*(3), 517-539.

Gittell, J. H. (2002). Coordinating mechanisms in care provider groups: Relational coordination as a mediator and input uncertainty as a moderator of performance effects. *Management Science, 48*(11), 1408-1426.

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*(2), 105-112.

Hansen, L. O., Young, R. S., Hinami, K., Leung, A., & Williams, M. V. (2011). Interventions to reduce 30-Day rehospitalization: A systematic review. *Annals of Internal Medicine, 155*(8), 520-528.

Hollenberg, S., & Heitner, S. (2012). Congestive heart failure. *Cardiology in Family Practice: A practical Guide, 1*, 91-111.

Jencks, S. F., Williams, M. V., & Coleman, E. A. (2009). Rehospitalizations among patients in the Medicare fee-for-service program. *New England Journal of Medicine, 360*(14), 1418-1428.

Kianfar, S., Carayon, P., Hundt, A. S., & Hoonakker, P. (2014). Understanding Care Coordination for Chronically ill Patients. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 58*, 170-174.

Kianfar, S., Carayon, P., Hundt, A. S., Hoonakker, P., Alyousef, B., Tomcavage, J., . . . Walker, J. (2013, March). *Care providers' perception of care coordination team members*. Paper presented at the International Symposium on Human Factors and Ergonomics in Health Care: Advancing the Cause, Baltimore, MD.

Klein, G. (2001). Features of team coordination. In M. McNeese, E. Salas, & M. Endsley (Eds.), *New Trends in Cooperative Activities: Understanding System Dynamics in Complex Environments* (pp. 68-95). Santa Monica, CA: The Human Factors and Ergonomics Society.

Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological Science in the Public Interest, 7*(3), 77-124.

Leppin, A. L., Gionfriddo, M. R., Kessler, M., & et al. (2014). Preventing 30-day hospital readmissions: A systematic review and meta-analysis of randomized trials. *JAMA Internal Medicine, 174*(7), 1095-1107.

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R., . . . Grober, E. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Quality and Safety in Health Care, 13*(5), 330-334.

Lingard, L., & Haber, R. J. (1999). Teaching and learning communication in medicine: a rhetorical approach. *Academic Medicine, 74*(5), 507-510.

Maliski, S. L., Clerkin, B., & Litwin, M. S. (2004). Describing a nurse case manager intervention to empower low-income men with prostate cancer. *Oncology Nursing Forum, 31*(1), 57-64.

Malone, T. W., & Crowston, K. (1990). *What is coordination theory and how can it help design cooperative work systems?* Paper presented at the Proceedings of the 1990 ACM conference on Computer-supported cooperative work.

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys, 26*(1), 87-119.

Malone, T. W., Crowston, K., Lee, J., Pentland, B., Dellarocas, C., Wyner, G., . . . O'Donnell, E. (1999). Tools for inventing organizations: Toward a handbook of organizational processes. *Management Science, 45*(3), 425-443.

Malone, T. W., Crowston, K. G., & Herman, G. (Eds.). (2003). *Organizing Business Knowledge: The MIT Process Handbook*. Cambridge, MA: MIT Press.

McDonald, K. M., Schultz, E., Albin, L., Pineda, N., Lonhart, J., & Sundaram, V. (2011). Care Coordination Measures Atlas. Rockville, MD: Agency for Healthcare Research and Quality.

McDonald, K. M., Sundaram, V., Bravata, D. M., Lewis, R., Lin, N., Kraft, S., . . . Owens, D. K. (2007). Care coordination. In M. K. Shojania KG, Wachter RM, Owens DK (Ed.), *Closing the quality gap: A critical analysis of quality improvement strategies* (Vol. 7). Rockville, MD: Agency for Healthcare Research and Quality.

Moran, W. P., Messick, C., Guerette, P., Anderson, R., Bradham, D., Wofford, J. L., & Velez, R. (1994). A practice-based information system for multi-disciplinary care of chronically ill

patients: what information do we need? The Community Care Coordination Network Database Group. *Proceedings of the Annual Symposium on Computer Application in Medical Care*, 585-589.

Murphy, S. L., Xu, J., & Kochanek, K. D. (2013). *Deaths: Final data for 2010*. Retrieved from Hyattsville, MD:

Nutting, P. A., Crabtree, B. F., Miller, W. L., Stange, K. C., Stewart, E., & Jaén, C. (2011). Transforming physician practices to patient-centered medical homes: Lessons from the national demonstration project. *Health Affairs, 30*(3), 439-445.

Oliva, N. L. (2010). A closer look at nurse case management of community-dwelling older adults: Observations from a longitudinal study of care coordination in the chronically Ill. *Professional Case Management, 15*(2), 90-100.

Osborn, R., Moulds, D., Squires, D., Doty, M. M., & Anderson, C. (2014). International survey of older adults finds shortcomings in access, coordination, and patient-centered care. *Health Affairs, 33*(12), 2247-2255.

Patton, M. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research, 34*(5 Pt 2), 1189–1208.

Pauwels, R. A., Buist, A. S., Calverley, P. M. A., Jenkins, C. R., & Hurd, S. S. (2001). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 163*(5), 1256-1276.

Pham, H. H., O'Malley, A. S., Bach, P. B., Saiontz-Martinez, C., & Schrag, D. (2009). Primary care physicians' links to other physicians through Medicare patients: The scope of care coordination. *Annals of Internal Medicine, 150*(4), 236-242.

Powers, B. W., Chaguturu, S. K., & Ferris, T. G. (2015). Optimizing high-risk care management. *JAMA, 313*(8), 795-796.

Quarells, R. C., Liu, J., & Davis, S. K. (2012). Social determinants of cardiovascular disease risk factor presence among rural and urban Black and White men. *Journal of Men's Health, 9*(2), 120-126.

Robson, C. (2011). *Real World Research* (Third ed.). Chichester, UK: John Wiley & Sons.

Rosenberg, C. N., Peele, P., Keyser, D., McAnallen, S., & Holder, D. (2012). Results from a patient-centered medical home pilot at UPMC health plan hold lessons for broader adoption of the model. *Health Affairs, 31*(11), 2423-2431.

Rudin, R. S., & Bates, D. W. (2014). Let the left hand know what the right is doing: a vision for care coordination and electronic health records. *Journal of the American Medical Informatics Association, 21*(1), 13-16.

Salas, E., Cooke, N. J., & Gorman, J. C. (2010). The science of team performance: progress and the need for more…. *Human Factors, 52*(2), 344-346.

Salas, E., Wilson, K. A., Murphy, C. E., King, H., & Salisbury, M. (2008). Communicating, coordinating, and cooperating when lives depend on it: Tips for teamwork. *Joint Commission Journal on Quality and Patient Safety, 34*(6), 333-341.

Saldana, J. (2009). *The coding manual for qualitative researchers*. London: Sage Publications.

Samal, L., Dykes, P. C., Greenberg, J., Hasan, O., Venkatesh, A. K., Volk, L. A., & Bates, D. W. (2013). The Current Capabilities of Health Information Technology to Support Care Transitions. *AMIA Annual Symposium Proceedings, 2013*, 1231-1231.

Sandelowski, M. (1995). Sample size in qualitative research. *Research in Nursing & Health, 18*(2), 179-183.

Schoen, C., Osborn, R., Squires, D., Doty, M., Pierson, R., & Applebaum, S. (2011). New 2011 survey of patients with complex care needs in eleven countries finds that care is often poorly coordinated. *Health Affairs, 30*(12), 2437-2448.

Scholle, S. H. (2010). *Engaging Patients and Families in the Medical Home*: Agency for Healthcare Research and Quality, US Department of Health and Human Services.

Steele, G. D., Haynes, J. A., Davis, D. E., Tomcavage, J., Stewart, W. F., Graf, T. R., . . . Shikles, J. (2010). How Geisinger's advanced medical home model argues the case for rapid-cycle innovation. *Health Affairs, 29*(11), 2047-2053.

Stille, C. J., Jerant, A., Bell, D., Meltzer, D., & Elmore, J. G. (2005). Coordinating care across diseases, settings, and clinicians: A key role for the generalist in practice. *Annals of Internal Medicine, 142*(8), 700-708.

Sundstrom, E., de Meuse, K. P., & Futrell, D. (1990). Work teams: Applications and effectiveness. *American Psychologist, 45*(2), 120-133.

Takeda, A., Taylor, S., Taylor, R., Khan, F., Krum, H., & Underwood, M. (2012). Clinical service organisation for heart failure. *Cochrane Database of Systematic Reviews*.

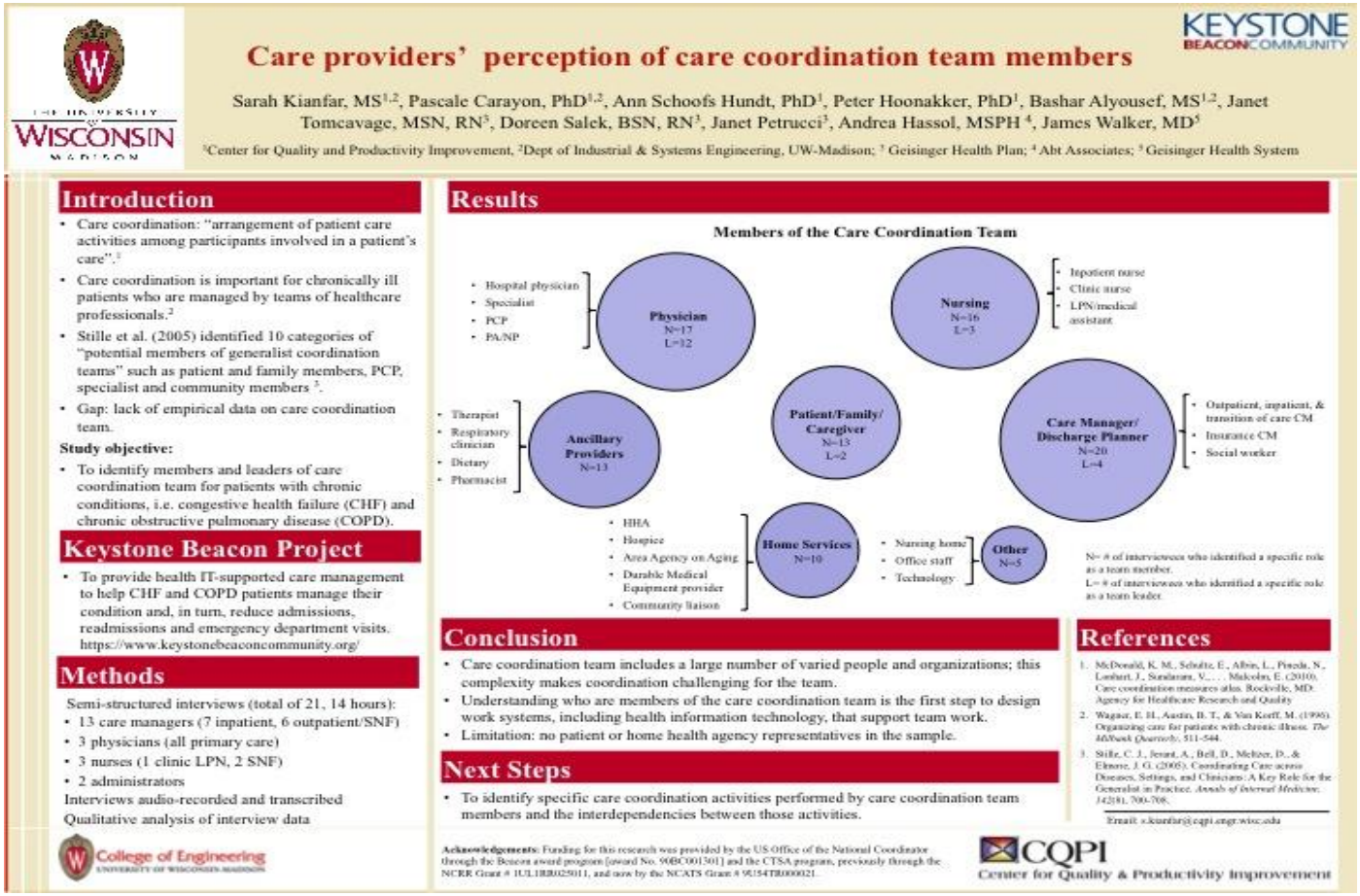
Vest, J. R., Bolin, J. N., Miller, T. R., Gamm, L. D., Siegrist, T. E., & Martinez, L. E. (2010). Review: Medical Homes: "Where You Stand on Definitions Depends on Where You Sit". *Medical Care Research and Review, 67*(4), 393-411.

Ward, B. W., Schiller, J. S., & Goodman, R. A. (2014). Multiple Chronic Conditions Among US Adults: A 2012 Update. *Preventing Chronic Disease, 11*, E62.

Zeisel, J. (1984). *Inquiry by design: Tools for environment--behavior research*. Cambridge University Press.

Appendices

Appendix 1: Kianfar et al. (2013). Care providers' perception of care coordination team members. Paper presented at the International Symposium on Human Factors and Ergonomics in Health Care: Advancing the Cause, Baltimore, MD.



Care providers' perception of care coordination team members

Sarah Kianfar, MS[1,2], Pascale Carayon, PhD[1,2], Ann Schoofs Hundt, PhD[1], Peter Hoonakker, PhD[1], Bashar Alyousef, MS[1,2], Janet Tomcavage, MSN, RN[3], Doreen Salek, BSN, RN[3], Janet Petrucci[3], Andrea Hassol, MSPH [4], James Walker, MD[5]

[1]Center for Quality and Productivity Improvement, [2]Dept of Industrial & Systems Engineering, UW-Madison; [3] Geisinger Health Plan; [4] Abt Associates; [5] Geisinger Health System

Introduction

- Care coordination: "arrangement of patient care activities among participants involved in a patient's care".[1]
- Care coordination is important for chronically ill patients who are managed by teams of healthcare professionals.[2]
- Stille et al. (2005) identified 10 categories of "potential members of generalist coordination teams" such as patient and family members, PCP, specialist and community members [3].
- Gap: lack of empirical data on care coordination team.

Study objective:

- To identify members and leaders of care coordination team for patients with chronic conditions, i.e. congestive health failure (CHF) and chronic obstructive pulmonary disease (COPD).

Keystone Beacon Project

- To provide health IT-supported care management to help CHF and COPD patients manage their condition and, in turn, reduce admissions, readmissions and emergency department visits. https://www.keystonebeaconcommunity.org/

Methods

Semi-structured interviews (total of 21, 14 hours):

- 13 care managers (7 inpatient, 6 outpatient/SNF)
- 3 physicians (all primary care)
- 3 nurses (1 clinic LPN, 2 SNF)
- 2 administrators

Interviews audio-recorded and transcribed

Qualitative analysis of interview data

Results

Members of the Care Coordination Team

Conclusion

- Care coordination team includes a large number of varied people and organizations; this complexity makes coordination challenging for the team.
- Understanding who are members of the care coordination team is the first step to design work systems, including health information technology, that support team work.
- Limitation: no patient or home health agency representatives in the sample.

Next Steps

- To identify specific care coordination activities performed by care coordination team members and the interdependencies between those activities.

References

1. McDonald, K. M., Schultz, E., Albin, L., Pineda, N., Lonhart, J., Sundaram, V., . . . Malcolm, E. (2010). Care coordination measures atlas. Rockville, MD: Agency for Healthcare Research and Quality.
2. Wagner, E. H., Austin, B. T., & Von Korff, M. (1996). Organizing care for patients with chronic illness. *The Milbank Quarterly*, 511-544.
3. Stille, C. J., Jerant, A., Bell, D., Meltzer, D., & Elmore, J. G. (2005). Coordinating Care across Diseases, Settings, and Clinicians: A Key Role for the Generalist in Practice. *Annals of Internal Medicine, 142*(8), 700-708.

Email: s.kianfar@cqpi.engr.wisc.edu

Acknowledgements: Funding for this research was provided by the US Office of the National Coordinator through the Beacon award program [award No. 90BC001301] and the CTSA program, previously through the NCRR Grant # 1UL1RR025011, and now by the NCATS Grant # 9U54TR000021.

Appendix 2: Kianfar et al. (2014). Understanding Care Coordination for Chronically ill Patients. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 58, 170-174.

Understanding Care Coordination for Chronically ill Patients

Sarah Kianfar[1 2], Pascale Carayon[1 2], Ann Schoofs Hundt[2] and Peter Hoonakker[2]
[1]Department of Industrial and Systems Engineering, University of Wisconsin-Madison, Madison, WI, USA

[2]Center for Quality and Productivity Improvement, University of Wisconsin-Madison, Madison, WI, USA

Care coordination is important for chronically ill patients who need assistance from a variety of care professionals, and often transition through different care settings. This paper provides an overview of coordination and its implications for the care of chronically ill patients. Using 12 interviews of different healthcare professionals involved in coordinating care of chronically ill patients, we provide examples of care coordination situations (e.g., patient discharged home with home health services) and identify coordination activities (e.g., communication for arranging resources, building relationships to facilitate information exchange, monitoring patients to plan follow up care) performed by different healthcare professionals.

INTRODUCTION

Chronically ill patients need assistance from a variety of care professionals, and often transition through different care settings (e.g., hospital, clinic, nursing home) (Bodenheimer, 2008). Unsafe transitions from hospitals to outpatient settings put chronically ill patients, including those with heart failure and lung disease, at risk of re-hospitalization, medical error or even death (Jencks et al., 2009). These risks can be reduced by improving follow-up care and care coordination (Jencks et al., 2009). Care coordination is a priority area for improving healthcare quality (Institute of Medicine, 2003), and care coordination interventions can improve outcomes (e.g., reduced mortality and hospital admissions) for chronically ill patients (McDonald et al., 2007). Therefore, it is important to understand care coordination for chronically ill patients.

This paper provides an overview of coordination and its implications for the care of chronically ill patients, specifically patients with congestive heart failure (CHF) and chronic obstructive pulmonary disease (COPD). Using a qualitative research approach, we provide examples of care coordination situations and identify care coordination activities performed by different healthcare professionals.

LITERATURE REVIEW

This section provides an overview of coordination and various approaches to care coordination.

Overview of Coordination

Coordination is "the act of managing interdependencies between activities performed to achieve a goal" (Malone & Crowston, 1990, p. 361). Interdependencies have been described as an essential component of coordination (Klein, 2001; Malone & Crowston, 1990). Interdependencies are "common objects" that are included in different activities that need to be performed (Malone & Crowston, 1990). Different types of common objects lead to different constraints or interdependencies. The output of an activity needed by another activity creates a sequencing constraint or "pre-requisite" interdependency. A resource needed by more than one activity creates a resource allocation constraint or "shared resources" interdependency. When more than one activity needs to occur at the same time, a timing constraint or "simultaneity" interdependency is created (Malone & Crowston, 1990).

Communication has been described as an essential element of coordination (Gittell, 2002; Klein, 2001; Malone & Crowston, 1990; Salas et al., 2008). Communication is the exchange of information between different people involved in the coordination process (i.e. team members) so they can make group decisions (Malone & Crowston, 1990) and plan their activities (Klein, 2001). In addition to explicit forms of communication used for planning and strategizing (Klein, 2001), team coordination also involves implicit communication, e.g., anticipating other members' actions and responding to them without explicit communication (Entin & Serfaty, 1999). Implicit communication relies on a team's shared mental model and is often used when a team performs under stressful conditions (Entin & Serfaty, 1999). Implicit communication may not be possible when coordination occurs across organizational boundaries. It is more difficult for people located in different organizations to develop a shared mental model, especially if they work together infrequently; this is often the case for care coordination of chronically ill patients.

In addition to communication, Gittell (2002) emphasizes the role of relationships between people in coordination. According to the theory of relational coordination (Gittell, 2002), people who have better relationships can coordinate their activities more effectively. Relational coordination is a key characteristic of high-performance and resilient work systems (Gittell, 2008; Gittell, Seidner, & Wimbush, 2010).

Monitoring is another important element of coordination (Klein, 2001; Salas et al., 2008), which includes monitoring changes in the situation, monitoring other members and monitoring progress of the plan (Klein, 2001). Collaborative cross-checking is an example of monitoring that can facilitate coordination (Patterson, Woods, Cook, & Render, 2007).

Care Coordination

In the context of healthcare, coordination of care is of great importance, especially for chronically ill patients. Care coordination has been described as "the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services. Organizing care involves the marshalling of personnel and other resources needed to carry out all required patient care activities, and is often

managed by the exchange of information among participants responsible for different aspects of care" (McDonald et al., 2011, p.4; McDonald et al., 2007, p. 5). According to McDonald et al. (2011), coordination activities are "actions that help achieve coordination" (p. 12), such as communication, facilitating transition, monitoring, connecting to community resources and aligning resources with patient and population needs.

Rudin and Bates' (2014) framework for care coordination activities performed by healthcare providers identifies care coordination areas where health IT can help. The framework categorizes care coordination activities performed by providers in four groups: (1) identifying collaborators, (2) contacting collaborators, (3) collaborating and (4) monitoring.

Conclusion of Literature Review

Coordination, i.e. managing interdependencies, is a process that involves communication, relationship building and monitoring. This process is achieved through a series of activities, i.e. coordination activities. Understanding these activities is critical to improve care coordination for chronically ill patients. Although the care coordination activities described in the literature are a good basis for this research, they are not specific to patients with CHF and COPD. Moreover, Rudin and Bates (2014) care coordination activities are limited to providers only. In this study, we describe care coordination activities performed for patients with CHF and COPD by various healthcare professionals in outpatient and inpatient settings.

METHODS

Study Setting and Sample

This study was part of a larger project on health-IT supported care management aimed at helping patients with CHF and COPD to better manage their condition and at reducing and preventing hospital admissions, readmissions, and emergency department visits. In this project, care managers were assigned to inpatient and outpatient settings to coordinate care for CHF and COPD patients. We interviewed a total of 12 healthcare professionals: 8 care managers (3 inpatient, 5 outpatient), 1 primary care physician, 1 administrator in a home health agency, 1 administrator in a nursing home and 1 administrator in a hospital. Participants were recruited because of their role in care coordination for CHF and COPD patients.

Study Procedures

Institutional Review Board approval was obtained from participating healthcare organizations and the researchers' academic institution. Semi-structured interviews with the 12 participants helped us understand the coordination activities associated with care of CHF and COPD patients. Different scenarios of coordination with different interdependencies were presented to interviewees depending on their role: patients seen in clinic; patients that have been hospitalized and discharged home; and patients that have been hospitalized and discharged to a skilled nursing facility. Interviewees were asked to describe situations where coordination went well and situations where coordination did not go well. The average duration of interviews was 51 minutes (min: 32 minutes; max: 1 hour and 3 minutes). The total duration for the 12 interviews was 10 hours and 11 minutes. Interviews were audio-recorded and transcribed by a professional transcription service.

Data analysis

Interviews were analyzed using a phenomenological approach (Hycner, 1985) with the focus on the phenomenon of coordination. Transcripts were reviewed and coordination-related data, including coordination activities, were identified. The main criterion for identifying a care coordination activity was existence of interdependencies (i.e. pre-requisite, shared resources, simultaneity) (Malone & Crowston, 1990). Pre-requisite interdependency exists when one activity needs to occur before the next activity can happen. Shared resources interdependency exists when an activity requires two or more people to share patient information, and knowledge or insights about a patient. Simultaneous interdependency exists when two or more activities need to happen at the same time. We organized care coordination activities based on the components of communication, relationship building and monitoring.

RESULTS

We present examples of coordination activities associated with the care of CHF and COPD patients (see table 1).

Communication

Healthcare professionals communicate and exchange patient information with one another to coordinate patient care. For example, a primary care physician communicates with a specialist, hospitalist or other physicians to obtain patient information (e.g., medications). A primary care physician mentioned that patients come to her clinic with exacerbated symptoms (e.g., breathing problems) without remembering a change of medications suggested by their specialist. The primary care physician then contacts the specialist to get information on the patient's medications and develops a plan of care for the patient (pre-requisite and shared resources). The primary care physician then communicates the plan of care, including any special needs of the patient (e.g., equipment, therapy), to the care manager. An outpatient care manager explained: *"It [coordination] starts with good communication, up front, from the physician. And then I can jump it and say. Okay, well, what's your plan?"* The care manager needs plan of care information from the primary care physician (pre-requisite and shared resources) to arrange resources for the patient.

Arrangement of resources, such as home health services and nursing home, involves a series of communication and follow-up. For example, care managers or social workers send referrals to the home health agencies. When referrals are approved, they send patient information to the home health agencies (shared resources) and organize the arrival time between the patient and home health services (simultaneity). An outpatient care manager explained: *"I stated to home health, this is what I need, here's the information I'm faxing to them. I expect them to be in the home that evening".* Care managers or social workers also communicate problems experienced by patients to the physicians (shared resources) and make appointments for the patient if needed. An outpatient care manager explained: *"I would have been the one to give the patient an appointment and bring them in"*.

Relationship building

Relationships play an important role in coordinating care; these relationships can be between healthcare professionals or between a patient and a healthcare professional. For example, care managers or social workers that have a relationship with community services (e.g., home health agency) can arrange resources for patient more efficiently. A social work administrator at a nursing home explained: *"...really good relationship with*

the home health agencies, and I'll call, yes, I'm really sorry… this just happened. She [from home health] goes, we'll get that to his [patient's] house today… It's a lot of fast work". Good relationships also facilitate information exchange between healthcare professionals or between a patient and a healthcare professional (shared resources). An outpatient care manager mentioned: *"I've worked for every home health agency in the area, so they all know me… So they send me these electronic records… all vital information that I need".*

Table 12: Examples of care coordination activities for CHF and COPD patients

Coordination elements	**Interdependencies**		
	Pre-requisite	Shared resources	Simultaneity
Communication	Care managers need plan of care information from primary care physician to arrange resources for patients.	Care managers or social workers send patient information to home health agency once the referral is approved.	Care managers or social workers organize arrival time between patient and home health services.
Relationship building	Patient informs care manager of a problem (e.g., swollen legs) and care manager schedules a follow up appointment.	Home health nurse contacts outpatient care manager and sends her patient records to keep her informed.	
Monitoring	Care managers monitor patients using phone calls and telemonitoring system to ensure patient symptoms are under control.	When a patient is in nursing home, outpatient care manager monitors the patient by making follow up calls to the nursing home.	

The same outpatient care manager mentioned that good relationship with patients helps her in arranging follow-up care. Patients inform her if they encounter any problems (e.g., swollen legs) and she can then take action and schedule a follow-up appointment (pre-requisite and shared resources).

Monitoring

Different monitoring activities happen during care coordination, including: monitoring the health of the patient, monitoring changes in patient status, and monitoring activities of other healthcare professionals that care for the patient. For example, care managers monitor patient health using phone calls and a telemonitoring system for weight to ensure patient symptoms are under control (pre-requisite and shared resources). An outpatient care manager explained: *"[I monitor patients] until they're back to their baseline symptoms of, that they're not in congestion any longer".* When a patient's status changes (e.g., admission to hospital), a primary care physician may monitor the patient by contacting other physicians to get an understanding of the patient's status and be prepared for providing follow-up care after discharge (pre-requisite, shared resources). Care professionals also monitor each other. For example, an outpatient care manager stated that when a patient is at a nursing home, she gets in touch with a nurse there (shared resources) to make sure everything is taken care of for the patient. She explained: *"They [nurses at the nursing home] are too busy. They miss things. I have to do a lot of follow-ups."*

DISCUSSION AND CONCUSION

We identified communication, relationship building and monitoring as coordination

elements. These findings are similar to other research on coordination. The care coordination activities framework by Rudin and Bates (2014) includes communication (e.g., contacting collaborators) and monitoring. The relational coordination framework of Gittell (2002) emphasizes the role of relationship building in coordination.

In addition to identifying coordination elements, we emphasized the importance of interdependencies as a key component of coordination. Interdependencies are often overlooked in research on care coordination. We presented care coordination activities on two dimensions: 1) care coordination elements and 2) interdependencies. Not any communication activity is a care coordination activity, unless there is some type of interdependency involved. For instance, a primary care physician communicating the plan of care to a care manager is a care coordination activity because there is a pre-requisite interdependency involved: the care manager needs that information to arrange services for the patient.

Our data showed that communication and exchange of information occur in many care coordination activities (Alyousef et al., 2012; Carayon et al., 2012; Carayon et al., 2013). Future research can focus on designing health IT that facilitates care coordination activities such as communication. For example, providing an outpatient care manager with access to patients' electronic records in a nursing home for monitoring purposes would support communication. Another example is providing a primary care physician access to specialist's notes. It is important to identify interdependencies between activities of different healthcare professionals involved in care coordination to properly design health IT.

Our research focused on care coordination activities for CHF and COPD patients. Future research can assess care coordination activities for patients with different chronic conditions.

Our study did not include the perspective of patients about care coordination. There may also have been other healthcare professionals (e.g., specialist) whose perspectives could have enriched our research.

ACKNOWLEDGEMENTS

Funding for this research was provided by the US Office of the National Coordinator through the Beacon award program [award No. 90BC001301], and the CTSA program, previously through the NCRR Grant # 1UL1RR025011, and now by the NCATS Grant # 9U54TR000021.

REFERENCES

Bodenheimer, T. (2008). Coordinating care—a perilous journey through the health care system. New England Journal of Medicine, 358(10), 1064-1071.

Entin, E. E., & Serfaty, D. (1999). Adaptive team coordination. Human Factors, 41(2), 312-325.

Gittell, J. H. (2002). Coordinating mechanisms in care provider groups: relational coordination as a mediator and input uncertainty as a moderator of performance effects. Management Science, 48(11), 1408-1426.

Gittell, J. H. (2008). Relationships and resilience: Care provider responses to pressures from managed care. The Journal of Applied Behavioral Science, 44(1), 25-47.

Gittell, J. H., Seidner, R., & Wimbush, J. (2010). A relational model of how high-performance work systems work. Organization Science, 21(2), 490-506.

Hycner, R. H. (1985). Some guidelines for the phenomenological analysis of interview data. Human studies, 8(3), 279-303.

Institute of Medicine. (2003). Priority areas for national action: Transforming health care quality: The National Academies Press.

Jencks, S. F., Williams, M. V., & Coleman, E. A. (2009). Rehospitalizations among patients in the Medicare fee-for-service program. New England Journal of Medicine, 360(14), 1418-1428.

Klein, G. (2001). Features of team coordination. In M. McNeese, E. Salas & M. Endsley (Eds.), New Trends in Cooperative Activities: Understanding System Dynamics in Complex Environments (pp. 68-95). Santa Monica, CA: The Human Factors and Ergonomics Society.

Malone, T. W., & Crowston, K. (1990). What is coordination theory and how can it help design cooperative work systems? Paper presented at the Proceedings of the 1990 ACM conference on Computer-supported cooperative work.

McDonald, K. M., Schultz, E., Albin, L., Pineda, N., Lonhart, J., & Sundaram, V. (2011). Care coordination measures atlas. Rockville, MD: Agency for Healthcare Research and Quality.

McDonald, K. M., Sundaram, V., Bravata, D. M., Lewis, R., Lin, N., Kraft, S., . . . Owens, D. K. (2007). Care coordination. In M. K. Shojania KG, Wachter RM, Owens DK (Ed.), Closing the quality gap: A critical analysis of quality improvement strategies (Vol. 7). Rockville, MD: Agency for Healthcare Research and Quality.

Patterson, E., Woods, D., Cook, R., & Render, M. (2007). Collaborative cross-checking to enhance resilience. Cognition, Technology & Work, 9(3), 155-162.

Rudin, R. S., & Bates, D. W. (2014). Let the left hand know what the right is doing: a vision for care coordination and electronic health records. Journal of the American Medical Informatics Association, 21(1), 13-16.

Salas, E., Wilson, K. A., Murphy, C. E., King, H., & Salisbury, M. (2008). Communicating, coordinating, and cooperating when lives depend on it: Tips for teamwork. Joint Commission Journal on Quality and Patient Safety, 34(6), 333-341.

Appendix 3: Care processes in which participants are involved and their associated coordination activities and interdependencies

Participant	Care processes	Coordination activities and interdependencies	Interview question
Primary care physician (PCP)	Patient referred to and seen by specialist	**Prerequisite interdependency -** Information must be provided to and received from the specialist in order to manage patients properly and understand their clinical needs. **Communication-** PCP and specialist exchange information.	When a patient is referred to a specialist what needs to be done in order for the transition to go well?
	Patient admitted to hospital	**Triggering -** PCP is notified of patient admission to the hospital. **Prerequisite interdependency -** Information must be provided to and received from the hospital in order to manage patients properly and understand their clinical needs. **Communication -** PCP and the hospital exchange information.	When a patient is admitted to the hospital and is discharged, what needs to be done in order for the transition to go well?
	Patient discharged from hospital to home or facility other than home		
	Patient sees PCP in clinic and goes home	**Monitoring -** PCP ensures patient goes home with sufficient knowledge about managing his/her care (e.g. medication, lab tests) and sees patient in follow up visit or at next regular visit (e.g. quarterly) if necessary.	When a patient comes to clinic and goes home, what needs to be done in order for the transition to go well?

Participant	Care processes	Coordination activities and interdependencies	Interview question
Inpatient care manager (IP CM)	Patient admitted to the hospital	**Monitoring** - KBC IP CM assesses patient's needs in anticipation of discharge and makes appropriate arrangements.	When a patient is admitted to the hospital, what needs to be done to coordinate care in anticipation of discharge?
	Patient discharged from hospital to home or facility other than home	**Triggering -** KBC IP CM is notified of impending patient discharge **Prerequisite interdependency** - KBC IP CM performs some activities such as patient education, medication reconciliation and making follow up appointment to make sure patient is ready for transition to home or skilled nursing facility/long term facility. **Communication** - KBC IP CM and OP CM exchange information.	When a patients is discharged from the hospital to home or skilled nursing facility/long term facility what needs to be done for the transition to go well?
Outpatient care manager (OP CM)	Patient admitted to hospital	**Triggering-** KBC OP CM is notified of patient admission to the hospital. **Prerequisite interdependency** - Information must be provided to and received from the hospital in order to manage the patient properly and understand their clinical needs. **Communication-** KBC OP CM and the IP CM exchange information.	When a patient is admitted to the hospital and is discharged, what needs to be done for the transition to go well?
	Patient discharged from hospital to home or facility other than home		

Participant	Care processes	Coordination activities and interdependencies	Interview question
	Patient sees PCP in clinic and returns home	**Monitoring** – GHP MH CM follows up with patient ensure all services are being provided, patient is responding to them appropriately, and patient is complying with regimen; adjustments made as necessary and communicated to other providers.	When a patient comes to clinic and goes home, what needs to be done in order for the transition to go well?
Hospital social work administrator (IP SW)	Patient in the hospital	**Monitoring** - IP SW assesses patient's needs in anticipation of discharge and makes are appropriate arrangements are made.	While a patient is in the hospital, what needs to be done to coordinate their care in anticipation of discharge?
	Patient discharged from hospital to home or facility other than home	**Triggering -** IP SW is notified of impending patient discharge. **Prerequisite interdependency** - IP SW performs some activities such as discharge planning to make sure patient is ready for transition home or to skilled nursing facility/long term facility. **Communication** - IP SW and OP CM exchange information.	When a patient is discharged from the hospital what needs to be done for the transition to go well?
Nursing home social work administrator (SNF SW)	Patient admitted to hospital and returns to SNF on discharge	**Triggering -** SNF SW is informed and sometimes aware of patient admission to the hospital. **Prerequisite interdependency -** SNF SW needs information from the hospital in order to help manage patient at SNF. **Monitoring** - SNF SW monitors patient while in the SNF.	When a patient is admitted to hospital and returns to SNF, what needs to be done for the transition to go well?

Participant	Care processes	Coordination activities and interdependencies	Interview question
	Patient discharged to home from SNF	**Prerequisite interdependency** - SNF SW performs some activities to ensures patient is ready to transition home and will receive necessary services at home.	When a patient is discharged from the SNF to home, what needs to be done for the transition to go well?
Home health (HH) provider	Patient discharged to home from hospital	**Triggering -** HH provider receives order from a PCP, specialist or hospital physician **Simultaneity interdependency** - HH provider needs to work with some other home services providers (e.g. DME provider). **Communication -** HH provider and DME provider exchange information to make sure patient has the right equipment.	When a patient is discharged from the hospital or SNF to home, what needs to be done for this transition to go well?

Appendix 4A: Interview guide for PCP, OP CM

Care Coordination

The purpose of this interview is to better understand the coordination activities associated with chronically ill patients you care for. We are going to ask you about patients that are seen in clinic, patients that have been hospitalized and discharged home and patients that have been hospitalized and discharged to a skilled nursing facility. We like to know your specific role in the process of managing these patients. We will ask you questions about what can go well in the process of managing these patients (e.g. you got the information you needed in a timely manner, and everything was done for the patient in a timely and efficient manner). We also want to know what does not go well for you and for patient care when the process is poorly coordinated.

Do you have any questions before we begin?

Patient visit to PCP

☐ Consider a Beacon patient with CHF who has experienced a sudden weight gain and comes to clinic for an urgent visit.

- What is your role caring for this patient in this process (PCP visit)?
- Give us examples where the coordination for this patient was very good; where this process (PCP visit) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
- Give us examples where the coordination for this patient was poor; where this process (PCP visit) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Patient admitted to the hospital and discharged home (with home health)

☐ Consider a Beacon patient with CHF and COPD who experienced pulmonary exacerbations, while in the hospital had changes to his/her medication regimen and was discharged home with home health services.

- What is your role caring for this patient in this process (hospitalization and patient discharge home)?
- Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge home) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
- Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge home) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Patient admitted to the hospital and to skilled nursing facility

☐ Consider a Beacon patient with CHF, COPD and diabetes, who on discharge requires continued nursing care and was therefore discharged to a SNF.

- What is your role caring for this patient in this process (hospitalization and patient discharge to SNF)?
- Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge to SNF) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your

viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.

- Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge to SNF) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Wrap up questions:

From your view point, are there any other challenges in coordinating care of HF and COPD patients?

Do you have any questions for us?

Thank you for your participation.

References for interviewers

Definition of coordination: the act of managing interdependencies between activities performed to achieve a goal. (Malone, 1990)

Definition of care coordination team: the team of different people involved at various times in the patient's care to facilitate the appropriate delivery of health care services. (McDonald, et al. 2oo7. *Care Coordination*, in Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies. Technical Review 9)

Appendix 4B: Interview guide for IP CM, IP SW

Care Coordination

The purpose of this interview is to better understand the coordination activities associated with chronically ill patients you care for. We are going to ask you about patients that are seen in clinic, patients that have been hospitalized and discharged home and patients that have been hospitalized and discharged to a skilled nursing facility. We like to know your specific role in the process of managing these patients. We will ask you questions about what can go well in the process of managing these patients (e.g. you got the information you needed in a timely manner, and everything was done for the patient in a timely and efficient manner). We also want to know what does not go well for you and for patient care when the process is poorly coordinated.

Do you have any questions before we begin?

Patient admitted to the hospital and discharged home (with home health)

☐ Consider a Beacon patient with CHF and COPD who experienced pulmonary exacerbations, while in the hospital had changes to his/her medication regimen and was discharged home with home health services.

- What is your role caring for this patient in this process (hospitalization and patient discharge home)?
- Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge home) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
- Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge home) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Patient admitted to the hospital and to skilled nursing facility

☐ Consider a Beacon patient with CHF, COPD and diabetes, who on discharge requires continued nursing care and was therefore discharged to a SNF.

- What is your role caring for this patient in this process (hospitalization and patient discharge to SNF)?
- Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge to SNF) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
- Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge to SNF) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Wrap up questions:

From your view point, are there any other challenges in coordinating care of HF and COPD patients? Do you have any questions for us?

Thank you for your participation.

References for interviewers

Definition of coordination: the act of managing interdependencies between activities performed to achieve a goal. (Malone, 1990)

Definition of care coordination team: the team of different people involved at various times in the patient's care to facilitate the appropriate delivery of health care services. (McDonald, et al. 2oo7. *Care Coordination*, in Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies. Technical Review 9)

Appendix 4C: Interview guide for SNF SW

Care Coordination

The purpose of this interview is to better understand the coordination activities associated with chronically ill patients you care for. We are going to ask you about patients that are seen in clinic, patients that have been hospitalized and discharged home and patients that have been hospitalized and discharged to a skilled nursing facility. We like to know your specific role in the process of managing these patients. We will ask you questions about what can go well in the process of managing these patients (e.g. you got the information you needed in a timely manner, and everything was done for the patient in a timely and efficient manner). We also want to know what does not go well for you and for patient care when the process is poorly coordinated.

Do you have any questions before we begin?

Patient admitted to the hospital and to skilled nursing facility

- ☐ Consider a Beacon patient with CHF, COPD and diabetes, who on discharge requires continued nursing care and was therefore discharged to a SNF.
    - What is your role caring for this patient in this process (hospitalization and patient discharge to SNF)?
    - Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge to SNF) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
    - Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge to SNF) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
    - Patient information
    - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Wrap up questions:

From your view point, are there any other challenges in coordinating care of HF and COPD patients?

Do you have any questions for us?

Thank you for your participation.

References for interviewers

Definition of coordination: the act of managing interdependencies between activities performed to achieve a goal. (Malone, 1990)

Definition of care coordination team: the team of different people involved at various times in the patient's care to facilitate the appropriate delivery of health care services. (McDonald, et al. 2oo7. *Care Coordination*, in Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies. Technical Review 9)

Appendix 4D: Interview guide for HH provider

Care Coordination

The purpose of this interview is to better understand the coordination activities associated with chronically ill patients you care for. We are going to ask you about patients that are seen in clinic, patients that have been hospitalized and discharged home and patients that have been hospitalized and discharged to a skilled nursing facility. We like to know your specific role in the process of managing these patients. We will ask you questions about what can go well in the process of managing these patients (e.g. you got the information you needed in a timely manner, and everything was done for the patient in a timely and efficient manner). We also want to know what does not go well for you and for patient care when the process is poorly coordinated.

Do you have any questions before we begin?

Patient admitted to the hospital and discharged home (with home health)

☐ Consider a Beacon patient with CHF and COPD who experienced pulmonary exacerbations, while in the hospital had changes to his/her medication regimen and was discharged home with home health services.

- What is your role caring for this patient in this process (hospitalization and patient discharge home)?
- Give us examples where the coordination for this patient was very good; where this process (hospitalization and patient discharge home) went well. It was well coordinated. The patient received everything he/she needed. And the process also went well from your viewpoint. Tell us about these examples. We're interested in understanding what went well in terms of **coordination**.
- Give us examples where the coordination for this patient was poor; where this process (hospitalization and patient discharge home) did not go well. It was poorly coordinated. The patient did not receive everything he/she needed. And the process also did not go well from your viewpoint. Tell us about these examples. We're interested in understanding what did not go well in terms of **coordination**.

Follow up on anything that has a potential for interdependency

Interdependencies

- *Prerequisite:* one activity needs to occur in order for the next activity to happen
- *Shared resources*: an activity requires two (or more) people to share
  - Patient information
  - Knowledge/insights about patient
- *Simultaneous:* two (or more) activities need to happen at the same time

Wrap up questions:

From your view point, are there any other challenges in coordinating care of HF and COPD patients?

Do you have any questions for us?

Thank you for your participation.

References for interviewers

Definition of coordination: the act of managing interdependencies between activities performed to achieve a goal. (Malone, 1990)

Definition of care coordination team: the team of different people involved at various times in the patient's care to facilitate the appropriate delivery of health care services. (McDonald, et al. 2oo7. *Care Coordination*, in Closing the Quality Gap: A Critical Analysis of Quality Improvement Strategies. Technical Review 9)

Appendix 5: Coding book for care coordination activities

Coordination is "the act of managing interdependencies between activities performed to achieve a goal" (Malone & Crowston, 1990, p. 361). Coordination activities are "actions that help achieve coordination" (McDonald et al., 2011, p. 12). Interdependencies are an important characteristic of coordination activities. We use a two-dimension framework (see Table 1) to identify care coordination activities:

- Dimension 1: coordination activities
- Dimension 2: interdependencies

1. Coordination activities

We identified two coordination activities: communication and monitoring.

1.1 Communication is "exchange of information between a sender and a receiver" (Salas et al., 2008, p. 335) . Communication occurs when two or more people involved in the care of a chronically ill patient, i.e. care coordination team, exchange information related to this patient. As mentioned in section 2.3.2, members of care coordination team include patients and families, physicians, nurses, discharge planners/care managers, ancillary providers, home services and other (Kianfar et al., 2013). Team members may exchange information synchronously (e.g., in person, via phone) or asynchronously using various technologies (e.g., instant messaging, EHR).

- Writing notes in EHR: can be a communication activity when MD writes notes in the EHR for CM to read and be aware of the plan of care for patient.

Keywords: talk to, say, ask, follow up, tell, contact, send a message, call, discuss, communicate.

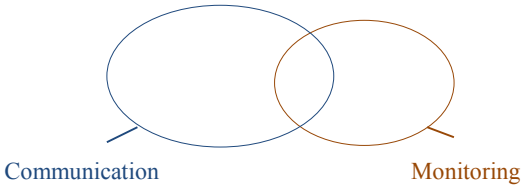
1.2 Monitoring[2] is evaluating the progress of activities. "Team members need to monitor the progress of the plan and also monitor changes in the situation" (Klein, 2001, p. 77). Team members need to review the progress of patient-related activities they are involved in to ensure patient needs are addressed. If changes occur in patient situation (e.g., change in symptoms), team members should make necessary adjustments to the patient care plan and resource arrangement (Klein, 2001; McDonald et al., 2011).

Keywords: make sure that, see something is wrong, check, follow up, find out why things are different, there was a change.

[2] "To check the progress or quality of something over a period of time" (Oxford Dictionary)

Monitoring activities may or may not involve communication.

- Monitoring with communication-example: CM talks to patient family on a regular basis to be informed about patient status and inform MD about patient.
- Monitoring without communication-example: CM reviews patient chart on a regular basis to stay informed about patient status.



Therefore, a coordination activity may involve communication, monitoring or both.

Keywords: follow up

2. Interdependencies

We have identified 4 types of interdependencies: flow, shared resources, simultaneity and fit (see Figure 1). Every coordination activity must have at least one type of interdependency.

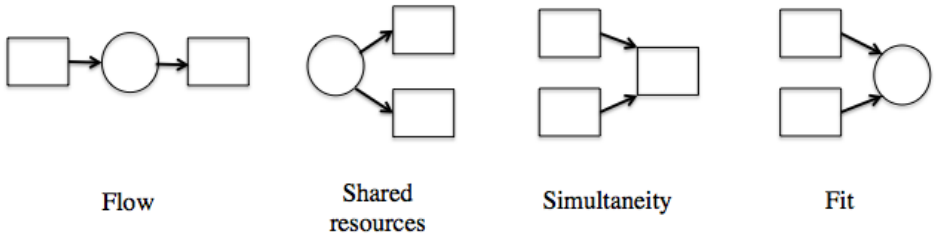


Figure 1: Different types of interdependencies. Boxes show activities and circles show resources/outputs. Adapted from (Malone et al., 2003). A breakdown in boxes, circles or arrows can lead to poor coordination.

2.1 Flow: Output of an activity used by another activity (sequencing constraint) (Malone & Crowston, 1990). The former is a producer activity and the latter is a consumer activity. The output of the producer activity may be information or a physical item that will be transferred to the consumer activity (Malone & Crowston, 1994).

- Example: CM gets notified that her patient is hospitalized; CM then reviews notes in EHR to stay informed about her patient.

Keywords: before, if… then…

2.2 Shared resources: A resource needed by two or more activities (resource allocation constraint) (Malone & Crowston, 1990). In other words, two activities have sharing dependency when "both have the same resource as a precondition"(Malone et al., 2003, p. 97). A resource is "everything used or affected by activities" (Malone et al., 2003, p. 91). A resource can be information, space, equipment, money, service or a person.

- Patient: can be a shared resource when MD and CM go to patient room together and interview patient together to get information and develop a plan of care.
- Notes in EHR: can be a shared resource when MD writes notes in the EHR for CM to read and be aware of the plan of care for patient.
    - In this example, notes are a resource shared between MD and CM. MD needs notes to communicate the plan of care with CM, and CM needs notes to be aware of the plan of care.
- Patient information: can be a shared resource when OP CM calls IP CM to get information about her hospitalized patient, and IP CM sends OP CM the information she needs.
    - Patient information is shared between OP CM and IP CM. OP CM needs patient information to be aware of plan of care for patient, and IP CM needs patient information to send to OP CM.

Keywords: can/cannot see information, no way of knowing

2.3 Simultaneity: Two or more activities need to occur at the same time (Malone & Crowston, 1990) or cannot occur at the same time (Malone & Crowston, 1994) (timing constraint).

- Example: MD and CM go to patient room together and interview patient together to get information and develop a plan of care.

Keywords: do this together, delay

A coordination activity may have more than one type of interdependency.

- Example (shared resource and simultaneity): MD and CM go to patient room together and interview patient together to get information and develop a plan of care.

Examples of coordination activities and their associated interdependencies are shown in Table 1.

Table 1: Examples of coordination activities and associated interdependencies

Coordination activities	**Flow:** Output of activity1 is used by activity2	**Shared resource:** A resource needed by multiple activities	**Simultaneity:** Activities need to occur at the same time
Communication	Activity1: Primary care physician assesses the patient and develops a plan of care. Activity2: Care manager arranges resources (e.g. equipment, therapy) for the patient based on the plan of care. Plan of care produced from activty1, is used by activity2.	Activity1: Care manager or social worker sends patient information to home health agency. Activity2: Home health agency reviews patient information. Both activities need patient information (resource).	Activity1: Care managers or social worker asks patient about estimated arrival time to home. Activity2: Care manager or social worker informs home health agency of arrival time of patient to home. Activity1 and 2 are needed for patient and home health nurse to arrive at patient home at the same time.
Monitoring	Activity1: Care manager monitors patient at home using phone calls or telemonitoring system. Activity2: Care manager needs to ensure patient symptoms and ensure they are under control. Patient information produced by activity1 is used by activity2.	Activity1: Care manager monitors patient at the nursing home by making follow up calls to the nursing home. Activity2: Care manager needs to ensure patient is receiving proper care at nursing home. Both activities need patient information (resource).	

Note: care coordination activities (process) are affected by work system factors of people involved in care coordination (structure). Work system factors may facilitate or hinder performing care coordination activities. Care coordination activities can then result in good or poor coordination (outcomes).

The focus of my coding was on care coordination activities. However, to study care coordination activities systematically, I also identified work system factors contributing to care coordination activities and outcomes associated with care coordination activities using the SEIPS model.

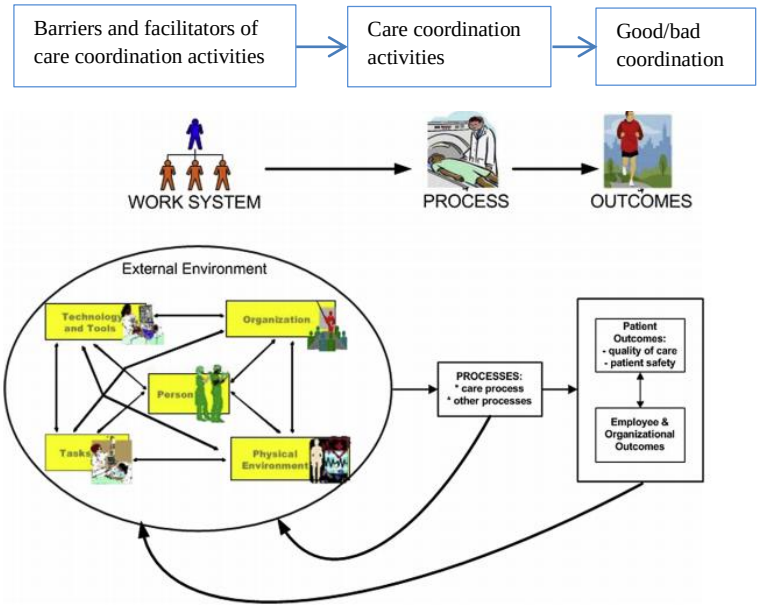


Figure 8: The SEIPS model of work system and patient safety (Carayon et al., 2006)

References

Carayon, P., Schoofs Hundt, A., Karsh, B.-T., Gurses, A. P., Alvarado, C. J., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: the SEIPS model. Quality and Safety in Health Care, 15(suppl 1), i50-i58.

Kianfar, S., Carayon, P., Hundt, A. S., Hoonakker, P., Alyousef, B., Tomcavage, J., . . . Walker, J. (2013, March). Care providers' perception of care coordination team members. Paper presented at the International Symposium on Human Factors and Ergonomics in Health Care: Advancing the Cause, Baltimore, MD.

Klein, G. (2001). Features of team coordination. In M. McNeese, E. Salas, & M. Endsley (Eds.), New Trends in Cooperative Activities: Understanding System Dynamics in Complex Environments (pp. 68-95). Santa Monica, CA: The Human Factors and Ergonomics Society.

Malone, T. W., & Crowston, K. (1990). What is coordination theory and how can it help design cooperative work systems? Paper presented at the Proceedings of the 1990 ACM conference on Computer-supported cooperative work.

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. ACM Computing Surveys, 26(1), 87-119.

Malone, T. W., Crowston, K., Lee, J., Pentland, B., Dellarocas, C., Wyner, G., . . . O'Donnell, E. (1999). Tools for inventing organizations: Toward a handbook of organizational processes. Management Science, 45(3), 425-443.

Malone, T. W., Crowston, K. G., & Herman, G. (Eds.). (2003). Organizing Business Knowledge: The MIT Process Handbook. Cambridge, MA: MIT Press.

McDonald, K. M., Schultz, E., Albin, L., Pineda, N., Lonhart, J., & Sundaram, V. (2011). Care Coordination Measures Atlas. Rockville, MD: Agency for Healthcare Research and Quality.

Salas, E., Wilson, K. A., Murphy, C. E., King, H., & Salisbury, M. (2008). Communicating, coordinating, and cooperating when lives depend on it: Tips for teamwork. Joint Commission Journal on Quality and Patient Safety, 34(6), 333-341.

Appendix 6: Coding instructions for care coordination activities

Coding instructions: After reviewing the framework of coordination activities and interdependencies from the coding book, follow steps below to analyze an interview.

1. Read transcript once.
2. Read transcript a second time. Identify and code coordination activities (communication and/or monitoring). From the coding book, read the definition of the coordination activity you coded. If your coding is consistent with the definition, keep it; otherwise change your coding to reflect the appropriate definition. A piece of text can be coded for one or two coordination activities.
    - The amount of text coded depends on the content of the activity. If you have several paragraphs as a coded piece of text, see if you can split it into single paragraphs. You may have the same coordination activity and the same interdependency, but the nature of activities may be different.
3. Read transcript a third time. Identify the interdependency associated with the coordination activity coded in step 2, then code the interdependency choosing from the list of interdependencies in section 2 of the coding book. Read the definition of the interdependency you chose. If your coding is consistent with the definition, keep it; otherwise change your coding to reflect the appropriate interdependency. A coordination activity can have more than one interdependency.
    - If you cannot identify an interdependency, the activity is unlikely to be a care coordination activity.
4. Read transcript a fourth time. If you identify additional coordination activities, go to step 2.
5. Read transcript a fifth time. Review your coding of coordination activities and interdependencies; make changes if needed. If you are unsure about your coding, make a note and bring for discussion.

Appendix 7: Example of diary

Process we used to come up with initial categories (and some activities standing alone): reading her summaries, taking marginal notes, having the interview excerpt side by side to refer to, writing up the numbers that are similar on the right side of the paper, as reading adding other numbers to the groups already made, and wrote up the activities and groups. Some activities stand alone and as we have more data I will add them to a category. We also noted the activities that were done in IP, OP or by Pt. I will keep track of those to see if anything emerges.

- Communication about setting up services (2, 3, 5, 7,12)
- Decision about SNF admission (7, 10, 4, 11)
- Catching errors, communicating about it and fixing it (8, 9, 11, 19, 20)
- Help pt. with insurance so that patient can visit PCP after d/c (1)- Setting up pt. apt. with PCP (transp.) (21)
- Something wrong with pt., discussion btw PCP and CM (16, 17)
- Anticipating what is needed for pt. visit with PCP (blood test) (6)
- Communication to ensure order placed for nausea (13)
- Communication btw CM and PCP- info from SNF RN imperfect (15)
- Communication with IP CM anticipating d/c (22)

Appendix 8: Coding book for communication events

Communication is "exchange of information between a sender and a receiver" (Salas et al., 2008, p. 335). Salas et al. (2008) use a model for teamwork in healthcare which is comprised of communication, coordination and cooperation. The communication component of Salas et al. (2008) model is based on a framework by Lingard et al. (2004) which identifies four parameter for communication:

- Content
- Context
- People involved
- Purpose

I use these four parameters to study communication that occurs between healthcare professionals for coordinating care of chronically ill patients during transitions of care (i.e., admission, discharge and transfer). An example is shown in Table 1.

1. Content: the information exchanged or "what is said" (Lingard & Haber, 1999). Content refers to the sufficiency and accuracy of information exchanged (Lingard et al., 2004). Care coordination related information includes information related to patient admission, discharge or transfer.

2. Context: "physical and temporal situation of an exchange" (Lingard et al., 2004, p. 331). Context refers to medium of communication and timing of information exchanged.

- Medium: method used to exchange information (e.g., face-to-face, phone call, email, instant message, paper chart, message sent through health-IT)
- Timing:
    - Synchronous: no delay in receiving the information (e.g., face-to-face, phone call, instant message).
    - Asynchronous: delay exists in receiving the information (e.g., email, paper chart, message sent through health-IT)

Timing of communication can be determined by the medium.

3. People involved: "composition of group engaged in communication" (Lingard et al., 2004, p. 332). People involved in communication are senders and receiver of information exchanged.

I use the 7 categories of care coordination team members for chronically ill patients described in section 2.3.2 to identify senders and receivers.

1) Patients and families
2) Physicians (e.g., hospitalist, specialist, primary care physician)
3) Nurses (e.g., inpatient nurse, clinic nurse)
4) Discharge planners/care managers (e.g., inpatient care manager, outpatient care manager, social worker)
5) Ancillary providers (e.g., therapist, pharmacist, dietitian)
6) Home services (e.g., home health agency, hospice)
7) Other (e.g., nursing home, office staff, technology)

4. Purpose: goals of the communication (Lingard et al., 2004, p. 331). Goals of communication related to care coordination include notification of patient admission, discharge or transfer.

Table 1: example of communication activities that occur for coordinating patient care

Communication activity	Content	Medium	People involved	Purpose
The IP CM says that OP CMs will IM her to see if the patient is still in the hospital (not discharged yet)	Information about patient discharge	Instant Message	IP CM, OP CM	Discharge
The IP CM says that OP CM will call and tell her that a Beacon patient is being sent to the hospital	Information about patient admission	Phone call	OP CM, IP CM	Admission
The IP CM says that she will find out a transfer by reading a note in the chart	Information about patient transfer	Paper chart	MD, IP CM	Transfer

References

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R., . . . Grober, E. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. Quality and Safety in Health Care, 13(5), 330-334.

Lingard, L., & Haber, R. J. (1999). Teaching and learning communication in medicine: a rhetorical approach. Academic Medicine, 74(5), 507-510.

Salas, E., Wilson, K. A., Murphy, C. E., King, H., & Salisbury, M. (2008). Communicating, coordinating, and cooperating when lives depend on it: Tips for teamwork. Joint Commission Journal on Quality and Patient Safety, 34(6), 333-341.

Appendix 9: Detailed results for RQ1

Coding of the 12 interviews resulted in a total of 258 care coordination activities. Of the 258 activities identified, 202 (78%) involved communication, 13 (5%) involved monitoring and 43 (17%) involved both communication and monitoring. A total of 100 (39%) activities involved flow interdependency, 112 (43%) activities involved shared resources interdependency, 35 (14%) activities involved both flow and shared resources interdependencies and 11 (4%) activities involved simultaneity interdependency. See Table 1 for details.

Table 1: Care coordination activities and interdependencies

Coordination activities	Interdependencies				
	F	SR	F&SR	S	Total
Communication	67 (11)	103 (12)	21 (8)	11 (4)	202 (12)
Monitoring	13 (7)	0	0	0	13 (7)
Communication & Monitoring	20 (10)	9 (5)	14 (5)	0	43 (12)
Total	100 (12)	112 (12)	35 (10)	11 (4)	258 (12)

Note: numbers in parenthesis represent the number of interviews in which the care coordination activities were mentioned; there were a total of 12 interviews. F= Flow, SR=Shared Resources, S=Simultaneity.

Qualitative content analysis of the 258 care coordination activities resulted in categories and sub-categories of care coordination activities (see Table 2).

Table 2: Categories and sub-categories of care coordination activities

Categories	Sub-categories			F	F&SR	SR	Total
Communication F, SR, F&SR	Arranging services for patient			25	3	15	43
	Exchanging information about errors and resolving them			3	6	17	26
	Exchanging information about discharge anticipation				1	19	20
	Exchanging information about patient admission and hospital stay					16	16
	Exchanging information about patient medications			13		2	15
	Exchanging information about patient in a facility			1	3	11	15
	Exchanging information about patient visit and plan of care			5		9	14
	Reporting patient symptoms and resolving them			9	2	2	13
	Arranging equipment for patient			5		7	12
	Deciding about patient admission to a facility			3	4	4	11
	Helping patients with appointment and transportation			3	2	1	6
	Total			67	21	103	191
Monitoring/ Communication & Monitoring F, SR, F&SR		M	C&M				
	Reviewing medications and services and detecting errors	7	30	19	12	6	37
	Reviewing patient symptoms and follow-up if needed	3	13	11	2	3	16
	Scheduling follow-up to review patient status	3		3			3
	Total	13	43	33	14	9	56
Communication S	Talking in the same location and developing a plan of care						5
	Exchanging information between different people at the same time						3
	Scheduling delivery of medication/services at time of patient arrival home						3
	Total						11
Total				100	35	112	258

Note: Colors in Table 2 correspond to those in Table 1. F= Flow, SR=Shared Resources, S=Simultaneity.

Communication F, SR, F&SR

1) Arranging services for patient (N=43):

Healthcare professionals communicate with each other and patients/families to discuss patients' needs for services. They then get authorization for patients to receive the services and set up those services. I identified 43 activities: 25 communication and flow, 15 communication and shared resources and 3 communication flow and shared resources. These activities were mentioned by 3 IP CMs, 2 TOC CMs, 1 OP CM, 1 GHP CM, 1 OP physician, 1 HH, 1 IP SW and 1 SNF SW.

Twenty-five communication and flow activities involve healthcare professionals exchanging information about patients' needs for services and setting up or authorizing those services. For example, care managers and social workers get authorization for patients from insurance companies or aging agencies to receive services. *"Our social workers and case managers, depending on the insurance, are calling the insurance company and getting the authorization for that stay at the nursing home" (IP SW)*. In another example, outpatient care managers and nursing home social workers arrange services for patients who are discharged home and who can benefit from additional services. *"After they get home and after the fact, I'll call and say, don't you think it would be beneficial if we had a nurse come in and talk with you? And they might be willing to accept it, but then it's up to me to get that all arranged from our end, and I'll do that" (GHP CM).*

Fifteen communication and shared resources activities involve healthcare professionals informing each other about patients' needs for services. For example, a GHP CM informs an IP CM about a patient's psychological issues and need for therapy. *"So I called inpatient to say listen, this is where we've been going, this is what we've been trying to get done. And they were able to facilitate getting neuro-psych consult the day he was admitted, who were able to do some formal testing and have him declared incompetent" (GHP CM)*. In another example, an OP CM manager informs a HH nurse about a patient's needs. *"Well, I call. We have to give the dynamics, exactly what I want, you know, exactly, even wound care. I mean, no matter what it is, I want to explain what my goals are, what we need to do, and I realize we can't do it all in one day, and that's what I have to explain to them" (OP CM).*

Three communication flow and shared resources activities involve hospital care managers and social workers talking about patients' needs for services and making sure those services are set up for the patients. If they think a specific service is needed for a patient, they may talk to the physician about it. *"Social workers get involved with asking for therapy consults from the physicians. So especially for those patients who might, we are, happen to be debilitated or, you know, not looking as strong as we think they really need to be to be able to go home. And often, the physicians will order that" (IP SW).*

2) Exchanging information about errors and resolving them (N=26):

Healthcare professionals identify and report discrepancies regarding medications, services and other aspects of patients' plan of care (e.g., appointments) to other healthcare professionals and patients; they attempt to resolve those discrepancies. I identified 27 such activities: 17 communication and shared resources, 6 communication flow and shared resources, and 3 communication and flow. These activities were mentioned by 3 IP CMs, 2 TOC CMs, 1 OP CM, 1 GHP CM and 1 HH.

Seventeen communication and shared resources activities involve healthcare professionals informing each other of discrepancies in different aspects of patients' plan of care. For example, a TOC CM calls an inpatient physician to express concern about a patient's lab results and ask for follow-up. *"I'll call the attending physician myself and say, you know, I'm really concerned about this patient's blood sugars. It doesn't appear that anybody is doing anything to correct them. They're all over the place. What are we doing?" (TOC CM).*

Six communication flow and shared resources activities involve healthcare professionals informing each other and patients about discrepancies in medications or services and resolving those discrepancies. For example, a TOC CM informs a PCP that home health is not set up for a patient; TOC CM then gets an order from the PCP and sets up home health for the patient. *"I will just call the PCP myself and say, they were saying home health needed to be involved. Home health was not set up. Can I have an order for home health? And I'll get it set up myself" (TOC CM).* In another example, a TOC CM informs an inpatient physician, through a nurse, about a patient being allergic to a medication; the physician then prescribes a different medication for the patient. *"So I was able to call the discharging physician. And first we hit nursing and, of course,*

they're like well, she was ordered on it. I'm like, she's allergic to it. And so I had to walk her back through all those steps to show the patient had knowledge that she was not to take it. So they ended up prescribing something different" (TOC CM).

Three communication and flow activities involve TOC CM contacting a physician or PA to get an order for medications and services that were not originally ordered. For example, a TOC CM informs a PCP that a patient cannot live home alone and needs nursing home; TOC CM then gets an order from the PCP and arranges nursing home for the patient. *"I would say it was probably an unsafe discharge, in the fact that she went home alone. It was last year. It was cold. Her daughter lived, probably over a half hour to an hour away. She had no way of getting food, no one to cook, and she was home alone. And so we ended up working with the primary care, and we were able to get her into the nursing home for some short-term rehab" (TOC CM)*.

3) Exchanging information about discharge anticipation (N=20): healthcare professionals talk about patients' needs in preparation for discharge. I identified 20 activities: 19 communication and shared resources and 1 communication flow and shared resources.

Nineteen communication and shared resources activities involve healthcare professionals informing each other about upcoming discharges and anticipated patient needs. For example, an IP CM informs an OP CM about a patient's diet and medication-taking habits right before the patient is discharged. *"If they don't seem to understand things about their diet or don't seem to be willing to do those things, I'll let the case manager know this was an issue in the hospital. And they told us that they weren't taking their medications, but she thought that they were. You know, those types of things I pass on to them" (IP CM).* In another example, a SNF SW asks a SNF nurse about a patient's family support and home condition to determine the patient's discharge needs. *"I definitely go to the nurses too. You know, they're on a feeding tube, you know, the wife is very compromised. Do you think she could learn this? You know, we talk, we have to talk about the whole dynamics of what's it like in their house too" (SNF SW)*. In another example, a hospitalist calls a PCP before discharging a patient and informs the PCP about the patient's needs after discharge. *"Hospitalists are pretty good about communicating back and forth to the primary care offices. So they'll talk with them up front, if they need to. And they're very good about calling at discharge and saying, I'm sending your patient so-and-so home and,*

sort of, here's a quick rundown of what's happening, and I'll get you a discharge summary out there" (IP SW).

One communication flow and shared resources activity involves OP CM being informed that a patient is in the hospital and calling the hospital to inquire about the patient's discharge. *"I get a notification through Wisdom that this patient is in the hospital, and sometimes I might make a phone call to the hospital to someone in case management to find out, what's the plan, you know, when are they getting discharged, what's going on?" (OP CM).*

4) Exchanging information about patient admission and hospital stay (N=16):

Healthcare professionals and patients/families inform each other about patients' admission to hospital and exchange information about patients' hospital stay. All of the 16 activities I identified involved communication and shared resources. These activities were mentioned by 2 OP CMs, 1 TOC CM, 1 IP CM, 1 PCP, 1 IP SW and 1 HH.

OP CMs are notified about patient admission by other healthcare professionals or patients/families and obtain information about patients' hospital stay. For example, an IP CM informs GHP CMs that a patient is in the hospital and provides information about the patient. *"I'll send a message to both of medical home care managers saying patient admitted to the hospital, COPD. Going to be new to either one of you. This is what I saw. This is what's going on. This is what needs to be done. And I'll forward it to them" (IP CM)*. OP CMs request information about their patients in the hospital if they cannot access the information. For example, an OP CM calls an IP CM to ask about a patient in the hospital whose information she cannot access. *"I could call one of them and say I have a patient in your hospital. Can you tell me what's going on or fax me the information, because I couldn't see that" (OP CM).*
Patients/families play a role in informing outpatient care managers or home health agency about patients' admission to hospital. For example, a patient or family member calls home health to inform them about the patient's hospital admission. *"So often patient knows, or their family members know to call home health if they are going in, taken to the hospital and whatever" (IP SW).*

5) Exchanging information about patient medications (N=15):

Healthcare professionals communicate with each other to arrange medications for patients, including affordable and free medications. I identified 15 activities: 13 communication and flow and 2 communication and shared resources. These activities were mentioned by 1 IP CM, 1 OP CM, 1 GHP CM, 1 TOC CM, 1 IP SW and 1 HH.

Thirteen communication and flow activities involve care managers and social workers getting medication orders from physicians, making sure medication are available at the pharmacy and getting affordable or free medications from pharmaceutical companies when needed. For example, a GHP CM gets medication order information from a PCP, pends the order and sends it to the PCP to sign. *"And in general, I pend the orders. I just need to know, from them, how much Lasix they want, how often they want it, and I will say, okay, I'm going to pend all those orders for everything we need, and I'll send it back to you" (GHP CM)*. In another example, an IP CM collects patient information and contacts pharmaceutical companies to apply for assistance program to get free medications for the patient. *"When we find patients who are having medication issues, that can't afford their meds and stuff, the case managers are typically doing the legwork on indigent programs or drug cards, discount cards, or how can we help this patient to be able to get what they need? So that's typically, the case manager is doing that, which may involve, again, calling a drug company, filling out paperwork for an application for their assistance program, collecting, sometimes, financial information from patients and families to be able to complete those applications and that kind of thing" (IP SW)*.

Two communication and shared resources activities were identified: The first activity involves a TOC CM informing a pharmaceutical coordinator that patient will need free medications for next month and they need to contact pharmaceutical companies. *"I had to call [pharmaceutical coordinator] again, we've got to get, you know, the pharmaceutical company involved here" (TOC CM)*. The second activity involves a HH nurse informing a physician that patient has not been taking a medication because it is expensive and asking the physician for an alternative medication. *"And we call and say, hey, you know, the drug is too expensive. They won't take it. They can't afford it. You've got to come up with something else" (HH).*

6) Exchanging information about patient in a facility (N=15):

Healthcare professionals exchange information with each other and patients (if possible) about a patient who is in nursing home or hospice or is receiving home health services. PCP makes a visit to the facility, if needed, to get a clear understanding of patient status. Healthcare professionals in the facility contact PCP if there are issues with the patient. I identified 15 activities: 11 communication and shared resources, 3 communication flow and shared resources, and 1 communication and flow. These activities were mentioned by 1 OP CM, 1 GHP CM, 1 TOC CM and 1 OP physician.

Eleven communication and shared resources activities involve outpatient, medical home or TOC care managers contacting nursing home to inquire about a patient. *"A lot of times I'll call the supervising nurse at the facility, to gather more information from them. I'm not getting a clear picture of what's going on with the patient, and could you please, you know, gather the information for me, and this is what I need" (TOC CM)*. GHP CM calls a patient at nursing home to get subjective information from the patient. *"Many times in a nursing home, I'll depend on the patient. They all have cell phones, no matter if they're in their 80's or 90's. So I'll call them up. Because I've been working with them on the outside, and so I'll get information from them. I'll get the objective data from the nurse, the vital signs, so the ins and outs, the numbers, where I'm not relying on subjectivity. And then I'll get the subjectivity from the patient" (GHP CM)*. HH staff update an OP CM about a patient's status on a regular basis. *"We have a rule that they fax me with any changes and an update every week, or they call me" (OP CM)*. If a nursing home patient has any problems, nursing home staff inform the PCP. *"And any problem that comes up during the day, you know, if he's having chest pain, that's a fax, you know, or a phone call. He's having some nausea, can I have some Tums? That's a fax. If he's got, seriously, an ingrown toenail, can we have an order for Epsom salts. That's a fax" (OP* physician*).*

Three communication flow and shared resources activities involve a GHP CM asking a SNF nurse or a HH nurse about a patient. If the GHP CM is not able to get a clear understanding of the patient's status from the nurses at facilities and feels that "something is wrong", then she asks the PCP to visit the patient at the facility. *"The same thing goes with home health. You know, whatever that nurse is reporting to me is all I can report to the physician. So it has to make sense to me, or we're going, we're shaking our heads and saying something's not right here. And I've had physicians go out to do home visits when we're not sure" (GHP CM)*.

One communication and flow activity involves a PCP writing orders for a patient while the patient is in the nursing home and the results being faxed to the PCP. *"We hand write the orders over there, review them with the nurse, say here's what I'm doing, you know, let's make sure this happens, call me if there's any problems. But then, you know, as the results come in, they're just, they're faxed over to us (PCP)"*.

7) Exchanging information about patient visit and plan of care (N=14):

Healthcare professionals exchange information about patients' clinic visit and plan of care with each other and with patients/families. I identified 14 activities: 9 communication and shared resources and 5 communication and flow. These activities were mentioned by 1 OP CM, GHP CM and 1 PCP.

Nine communication and shared resources activities involve healthcare professionals informing each other and patients/families about patients' visit with various physicians and different aspects of patients' plan of care (e.g., medication change). For example, a PCP asks a specialist about a patient's visit with the specialist when the patient is not able to provide information about the specialist visit. *"Sometimes, yeah. I'll come out to the office and ask (specialists), especially if somebody is really sick, and they, and the patient can't tell me, well, they've made a change on, and if somebody has been following with them, then, yes, I will step out and reach out to their specialist, who's, you know, managing their care" (OP* physician*)*. In another example, a PCP changes a patient's medication dose due to the patient's symptoms and a GHP CM informs the family and the pharmacy about the patient's medication dose change. *"There, is if somebody else is managing the medications, there needs to be communication from myself to the family member, perhaps the pharmacy, who provides it in blister packs, etc." (GHP CM)*.

Five communication and flow activities involve OP CMs or GHP CMs talking to PCPs or PAs about patients' visit to clinic and discussing patients' plan of care. For example, a PCP informs a GHP CM about a patient's visit to the clinic and then the GHP CM asks the PCP about the patient's plan of care. *"He'll come over to my office and say, so-and-so is here. He's in congestive heart failure. This is the plan. So it starts with good communication, up front, from the physician. And then I can jump in and say, okay, well, what's your plan?" (GHP CM).* In another example, an OP CM gives a patient's summary to a volunteer physician who comes to

the clinic and then the physician visits the patient and develops a plan of care. *"There's one volunteer doctor that comes in, and I will go in with the patient, and then I will give him a synopsis. This is the rundown. This is my patient. This is what's been going on. This is what I know about him. This is the psychosocial stuff. This is their economic situation. This is what's been happening. And then they get the whole picture. They go in, and they're able to come up with a plan" (OP CM)*.

8) Reporting patient symptoms and resolving them (N=13):

Care managers become aware of patients' problems and inform physicians to resolve the problems. I identified 13 activities: 9 communication and flow, 2 communication flow and shared resources, and 2 communication and shared resources. These activities were mentioned by 2 TOC CMs, 1 OP CM, 1 GHP CM, 1 IP CM, 1 OP physician and 1 HH.

Nine communication and flow activities involve outpatient or TOC care managers learning about patient symptoms and calling a PCP or a specialist to find a solution for the problem or bringing patients to the clinic. The PCP makes emergency home visits if needed. For example, a patient calls a TOC CM to inform her of a problem; the TOC CM then facilitates getting an appointment for the patient to come to the clinic. *"Well, they do call me if they're on my caseload. I sometimes get a call from my patients, or I'm calling them, so I might find out I'm not feeling well. I'm, you know, I'm having these symptoms. I've been coughing a lot. And then I would facilitate getting them an appointment based on their symptoms and how acute they were. I would go out and talk to the desk clerk, talk to the director" (TOC CM)*.

Two communication flow and shared resources activities were identified: The first activity involves an IP CM informing a nurse about a patient's nausea problem and the nurse getting an order for the patient. *"I went out and talked to the charge nurse and said that she was complaining of nausea, and nothing was ordered. So she called in and got an order for something for her. Just things like that, it depends on what comes up, you know" (IP CM)*. The second activity involves an OP CM informing an OP physician about a patient who is having problems and coming to the clinic. The OP CM then asks the OP physician what blood tests are needed in anticipation of the patient visit and OP physician identifies the types of lab work needed. *"Let's say patient weight gain prompted a phone call to the case manager, who then said*

to me, so-and-so is having this trouble, I'm bringing them in to see you later today. What blood work, would you like to have ordered? And so I would say, okay, let's get X, Y, and Z" (OP physician). In another example, a patient informs an OP CM about her problem and the OP CM calls a specialist and finds an answer for the patient. *"Patient had a care manager that she could call. And that care manager would have an answer to her same day, you know, would make phone call to the oncologist and get a response, would make those phone calls for her" (OP physician).*

Two communication and shared resources activities were identified: The first activity involves an OP CM informing a PCP about a patient's symptoms and the patient's visit to the clinic. *"I would have already forewarned the physician, these are the symptoms, this is what's going on, this is why I'm bringing them in" (GHP CM).* The second activity involves a family member informing a GHP CM about a problem with a patient. *"The family will call me to say, I am telling you there is something wrong with Dad" (GHP CM)*.

9) Arranging equipment for patient (N=12):

Healthcare professionals exchange information about patients' needs for equipment, get equipment orders for patients and inform patients about insurance requirements for the equipment. I identified 12 activities: 7 communication and shared resources and 5 communication and flow. These activities were mentioned by 1 TOC CM, 1 IP SW and 1 SNF SW.

Seven communication and shared resources activities involve healthcare professionals informing each other and patients about equipment needs and insurance and other requirements for getting the equipment. For example, therapists inform a SNF SW about a patient's need for a walker. *"When the therapists come back, they come back, and they do a report. They give me a copy, the family a copy, the resident a copy, and then on there is recommendations. You know, they have this, this, and this, but they're still going to need, you know, a walker" (SNF SW).* In another example, a SNF SW talks with a patient and the family about insurance coverage for equipment. *"My job is to talk with the family, the resident, and make them aware of what insurance covers, what insurance doesn't cover. Because, you know, nothing in the bathroom is covered, which is*

silly . . . you know, so if you need a raised toilet seat or bars, that's a private pay issue, you know" (SNF SW).

Five communication flow activities involve getting an equipment order for a patient and sending it to the providing company. For example, a TOC CM contacts inpatient physician for an equipment order and then faxes the order to the oxygen company. *"And I'll get in touch with the staff physician at (hospital) and make sure they either put the order in, and I'll fax it to the oxygen company or, you know, as long as the order is in, I can fax it" (TOC CM)*.

10) Decision about patient admission to a facility (N=11):

Healthcare professionals exchange information about patients' needs for going to a facility (e.g., nursing home, hospice) and make a decision about it. I identified 11 activities: 4 communication flow and shared resources, 4 communication and shared resources and 3 communication and flow. These activities were mentioned by 1 GHP CM, 1 IP CM, 1 IP SW, 1 SNF SW and 1 HH.

Four communication flow and shared resources activities involve healthcare professionals discussing patients' needs for going to a facility and making a decision about it. For example, a SNF nurse comes to hospital to talk to IP SWs and gather patient information. The SNF nurse later informs IP SWs about decision to admit the patient and IP SWs send the patient to the nursing home. *"(Nursing home admission nurse) will come see the social workers, talk to the social workers, pick up the chart, get what they need from the chart, take it back, let us know if they can accept the patient, and then when we send the patient" (IP SW).*

Four communication shared resources activities involve a facility not accepting patient or the patient rejecting to go to a facility. For example, a HH staff calls a hospital to inform them home health service is not appropriate for a patient, because the patient is not capable of staying at home. *"We may have to call back to the hospital, call back and say, you know, this is totally unsafe. This, you know, the ambulance dropped this patient off. They are now sitting in a recliner and unable to move, will not be able to get food, will not be able to take care of their personal needs. They can't stay here (HH)"*.

Three communication flow activities involve care managers or social workers referring patient to a facility and the facility accepting the patient. For example, IP SWs fax patients' referral to a facility and the facility usually accepts the patient. *"Our admission people get, the social worker at the hospital will fax over a referral. They ask the family, you know, give us your top three choices, we get a referral we review, and either accept or say we can or cannot handle them. Very seldom do we say no" (IP SW)*.

11) Helping patients with appointment and transportation (N=6):

Care managers help patients get appointments with their PCP while accommodating their transportation limitations. Care managers also arrange transportation for patients to go to a facility when needed. I identified 6 activities: 3 communication and flow, 2 communication flow and shared resources, and 1 communication and shared resources. These activities were mentioned by 1 GHP CM, 1 TOC CM and 1 IP CM.

Three communication and flow activities: two activities involve arranging transportation for patients to go to a facility. For example, an OP CM finds someone in the community who can take a patient to a facility and then the nurses in the facility take the patient in the facility. *"Generally, it's just trying to find somebody in the community who would be willing to get them in a car and get them. If we can get them to the facility, the nurses will come out and get them in a wheelchair and get them in there, I think" (OP CM)*. One activity involves a TOC CM calling a patient directly to make an appointment, to ensure the patient's transportation needs are met. *"If we are making an appointment, even for a patient, I try to have the person making the appointment call directly to the patient. Because they know their circumstances with transportation" (TOC CM).*

Two communication flow and shared resources activities were identified: The first activity involves a patient informing a IP CM about not having insurance and the IP CM calling a PCP and ensuring patient that can be seen at the PCP office. *"Patient was worried that his PCP wasn't going to see him yet because he didn't have it yet. He got home, and he was worried about, you know... I just kind of called the offices and made sure that everything was still in process for him and just reassured him" (IP CM)*. The second activity involves a TOC CM informing a PCP office staff about a patient's transportation issue at the time of appointment and

the PCP office staff calling the patient to re-schedule the appointment according to the patient's transportation availability.

One communication shared resources activity involves a GHP CM informing an ER CM that a patient needs transportation to go to a facility and for that reason the patient was sent to the ER to use the ambulance to get to the facility. *"I'm calling the ER case manager to say, listen, I don't think they need admission. I can't, you know, I can't get them, I can't have the ambulance take them from their home to the nursing home, because they're going to get hit with a bill, do you know what I mean?" (GHP CM)*.

Monitoring/Communication & Monitoring F, SR, F&SR

1) Reviewing medications and services and detecting errors (N=37):

Healthcare professionals review patient medications and services; if they find errors, they take follow-up action to correct the error. I identified 37 activities: 7 monitoring and flow, 6 communication monitoring and shares resources, 12 communication monitoring and flow, and 12 communication monitoring flow and shared resources. These 37 activities were mentioned by 3 IP CMs, 1 GHP CM, 1 OP CM, 2 TOC CMs, 1 HH and 1 SNF SW.

Seven monitoring and flow activities involve healthcare professionals reviewing patients' medications and services and detecting errors. For example, when a patient leaves a facility, a GHP CM ensures services needed by the patient are set up correctly. *"My job is to then, after they [patients]'re out [from facility], follow up and make sure all of those services got in place. And if they didn't, then I have to pick up the pieces and get them in place" (GHP CM).*

Six communication monitoring and shared resources activities involve healthcare professionals contacting each other to obtain information about patients' medication and service setup. For example, a TOC CM calls pharmacy and finds out there is no prescription for a patient's medications. *"They [PA] had not given the patient prescriptions for discharge medications that he had been previously on. He didn't have those. I called the pharmacy to see, did they really fill it, did they have any refills, is there any prescriptions like they're coming back today. And they didn't have any of that" (TOC CM).*

Twelve communication monitoring and flow activities involve healthcare professionals contacting patients or other healthcare professionals to inquire about the patients' medications and services and perform corrective actions if needed. For example, an OP CM calls a patient to see if the patient has all his/her medications; if not, she will work with a pharmacy to get affordable medications for the patient. In another example, a SNF SW calls assisted living to ask about a patient and finds out a therapist only visited the patient twice. The SNF SW then calls the therapy services and they visit the patient more often.

Twelve communication monitoring flow and shared resources activities involve healthcare professionals reviewing patients' medications and services, informing patients or other healthcare professionals if any problems exist and taking follow-up actions. For example, an IP CM reviews a patient's record and finds out the patient was discharged home from nursing home without previous medications. The IP CM then calls the primary care physician to get the correct medication list and sends it to nursing home. Another example, a TOC CM reviews discharge instructions and finds out home health was not ordered for a patient. The TOC CM then pages the discharging physician and asks him/her questions.

2) Reviewing patient symptoms and following-up if needed (N=16):

Healthcare professionals and patients monitor patients' symptoms, such as weight, and perform follow-up actions, such as visiting PCP. I identified 16 activities: 3 monitoring and flow, 3 communication monitoring and shared resources, 8 communication monitoring and flow and 2 communication monitoring flow and shared resources activities. These 16 activities were mentioned by 1 PCP, 1 GHP CM. 1 IP CM, 1 TOC CM, 1 OP CM, IP SW and 1 HH.

Three monitoring and flow activities involve healthcare professionals monitoring patients' symptoms and performing follow-up actions if needed. For example, a GHP CM can use telemonitoring system to know if patients are weighing themselves and to check their weight. *"We have the telemonitoring system, so in many cases, the scale is in the home, and I can tell what the weight is doing, or if they're not weighing themselves or, you know, the machine is not transmitting. Because I get all of those results at any time".* It is interesting to note that patients also monitor their own weight and come to clinic when their weight is high. *"They [patients]*

following daily weights, and their weight has gone up, and that's why they've come in" (OP physician*).*

Three communication monitoring and shared resources activities involve healthcare professionals contacting each other to share information about patients' symptoms. For example, a TOC CM asks a SNF nurse if she knows patient has gained 5 pounds in the last 2 days and if she has informed the physician about it. The TOC CM asks the SNF nurse to inform her once she talks to the physician. *"Did you know that they went up five pounds in two days? And different people might be weighing them, they're documenting it, but they didn't realize it, and did you call the doctor? And would you let me know what you find out?" (TOC CM).*

Eight communication monitoring and flow activities involve healthcare professionals monitoring patients' symptoms by contacting patients or other health care professionals and performing follow-up actions if needed. For example, an OP CM monitors patients' weight and informs a PCP if any problems exist. *"They [patients] go home, take that, case manager follows up the next day, continues to follow dry weights, and the case manager then coordinates with me, proactively"(OP* physician*).*

Two communication monitoring flow and shared resources activities involve healthcare professionals contacting patients or other healthcare professionals to obtain information about patients' symptoms and performing follow-up actions if needed. For example, a TOC CM checks a patient's blood sugar and asks a SNF nurse how the blood sugar is measured. *"If they're having those terrible lows, you want them to at least address that maybe the sliding scale needs to be altered, or are they checking the blood glucoses exactly at the right time? That's where you need to check with the nursing supervisor. Are they waiting two hours after the meal to check the blood glucose, you know?" (TOC CM).*

3) Scheduling follow-up to review patient status (N=3):

An OP CM schedules follow-ups for herself to review patients' record to stay updated with patients' status. I identified 3 activities involving monitoring and flow; all of the three activities are mentioned by 1 OP CM. *"So a lot of times I set follow-ups for myself just to do chart reviews to see, is there anything out there on this patient going on?" (OP CM).*

Communication S

1) Talking in the same location and developing a plan of care (N=5):

Being in the same location allows healthcare professionals and patients to communicate together face-to-face, share their thoughts and develop a plan together. I identified 5 activities; these activities were mentioned by two OP CMs.

The simultaneous nature of these five activities is due to the fact that they happen in the same location. For example, an OP CM talks to a patient and his/her family to discuss hospice service; the OP CM advises them about getting insurance for hospice. *"You can't get hospice if you're uninsured. So I had to work with her and her husband. We had to sit down and have a discussion about their finances, because she couldn't get on Medicaid… So as it all worked out, he had to get rid of the life insurance policy and prepay for his funeral so that she could get Medicaid" (OP CM).* In another example, an OP CM and a PCP go to the exam room together, assess the patient together, and brainstorm and develop a plan of care for the patient. *"Have another doc who wants me to come right in the room with him and is like this is great. We're going to do this together. We're going to interview the patient together. We're going to brainstorm and come up with ideas" (OP CM).*

2) Exchanging information between different people at the same time (N=3):

Healthcare professionals use technologies such as phone, IM, and conference call to exchange information. I identified 3 activities; these activities are mentioned by 1 OP CM and 1 GHP CM.

In these three activities, timeliness of information requires healthcare professionals to exchange information between each other using different technologies. For example, a patient has been discharged home but needs additional care. A GHP CM calls a nursing home to admit a patient and at the same time sends an instant message to an insurance care manager to authorize direct admit for the patient from home to nursing home: *"I was using my coworker's phone or my cell phone to get in contact with the nursing home people to say, can you take the patient? I was IMing the case manager at Geisinger Health Plan, who provides authorization for the direct admits, and just juggled it all to, you know, simultaneously" (GHP CM).* In another example, a

specialist puts an OP CM on conference call to hear a patient's assessment and participate in the plan of care development. *"We arranged it ahead of time... Had me on speakerphone. So during her [patient] assessment, after he [specialist] assessed her and came up with some plans, as they were sitting there, we all had a conference call" (OP CM).*

3) Scheduling delivery of medication and services at the time of patient arrival to home (N=3):

Healthcare professionals communicate with each other and patients/families to arrange the delivery of medications or other services with respect to patients' arrival time to home. I identified 3 activities; these activities were mentioned by 2 GHP CMs and 1 HH.

For example, a home health nurse needs to know at what time a patient will be home and at what time the infusion company will deliver the medications and supplies, because they all need to happen at the same time. *"Depending on what the patient is being referred for, you know, if it's a patient who's on IV antibiotics, and the IV is due at a certain time, we have to know, number one, what time they're going to be home, what time the drug is due, and has the infusion company delivered the medication and all the supplies to the home? Because it doesn't do any good if we're there at 5:00, the patient is there at 5:00, and we don't have the drug or the supplies" (HH).*

Barriers and facilitators associated with care coordination activities

During the interviews, participants mentioned work system barriers and facilitators associated with care coordination activities that they performed (see Table 3).

Table 3: number of barriers and facilitators associated with care coordination activities

Work system elements	Barriers	Facilitators
Person	17	1
Task	49	40
Tools and technology	4	48
Physical environment	2	4
Organization	13	17
Total	85	110

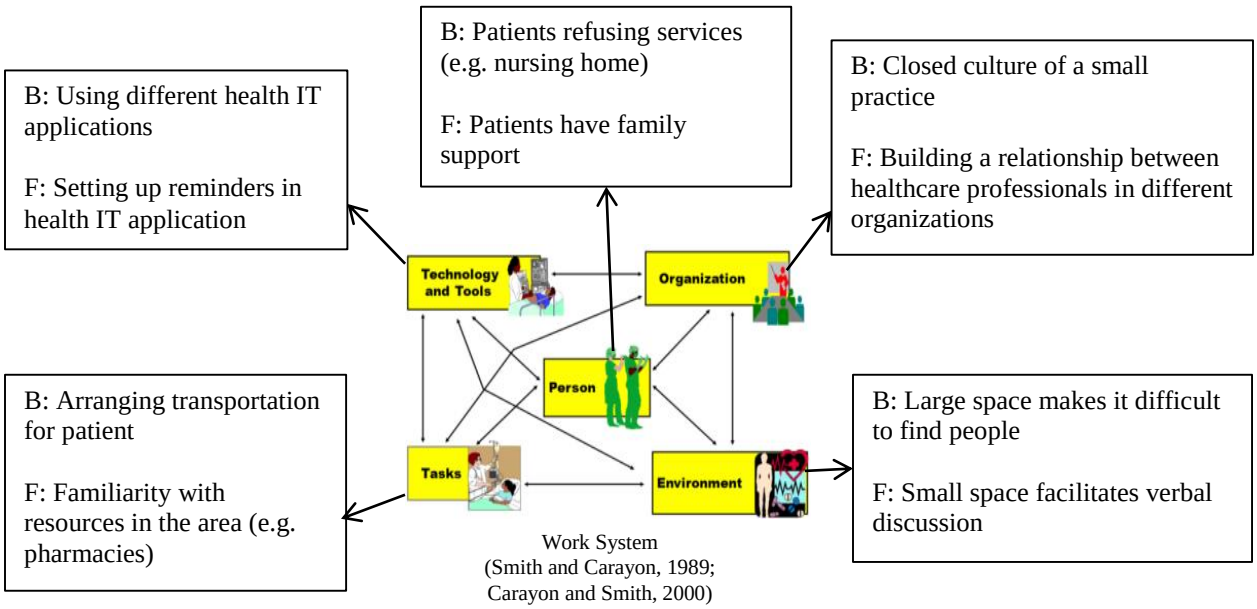
The "Person" category, which refers to the individual or team characteristics (Carayon et al., 2014), is mainly a barrier (17 barriers vs. 1 facilitator). Patients may refuse to accept services such as nursing home or home health after hospital discharge, refuse to make appointments with PCP or refuse to purchase certain medications. As a result of these decisions, patients' symptoms may get worse and they may have to be re-admitted to the hospital. Individual characteristics of patients can be barriers for healthcare professionals who are involved in coordinating patient care, such as care managers, because they want to make sure patients have the necessary resources to transition safely between care settings so that hospital readmissions can be prevented.

The "Tools and technology" category, on the other hand, is mainly a facilitator (4 barriers vs. 48 facilitators). The participants have access to patients' records and communicate with other healthcare professionals using various technologies such as phone, instant messaging (IM), voicemail and fax. In addition to physicians and care managers, the home health agency that we interviewed also had access to hospital EHR and the health information exchange system.

The "Task" category, which refers to the content, variety and physical and psychosocial demands of tasks (Carayon et al., 2014), is both a barrier and a facilitator (49 barriers vs. 40 facilitators). Participants appreciate the help and support they receive from their colleagues in performing their tasks, including information provided to them by their colleagues. On the other hand, they mention that other healthcare professionals do not cooperate with them in performing a task (e.g., do not provide information).

The "Physical environment" category is also both a barrier and a facilitators (2 barriers vs. 4 facilitators). Participants perceive smaller physical space (e.g. small clinic) as a facilitator for them to communicate with other team members. On the other hand, they perceive larger physical space (e.g. larger hospitals) as a barrier for them to reach out to people and communicate.

Figure 1: examples of barriers and facilitators associated with care coordination activities



The "Organization" category is both a barrier and facilitator (13 barriers vs. 17 facilitators). Participants perceived factors such as lack of training and close culture of small practices were as barriers. On the other hand, they perceive factors such as open culture of larger healthcare

institutions as a facilitator. Figure 1 shows some examples of barriers and facilitators for each category of work system elements.

Comparison between good and poor coordination

We identified examples of care coordination activities that lead to good or poor outcomes. Of the 258 care coordination activities presented in Table 1, a total of 42 (16%) activities lead to good coordination and 28 (11%) activities lead to poor coordination. These activities involve communication and/or monitoring with flow or shared resources interdependencies or both. Among activities with simultaneity interdependency, none was specifically linked to good or poor outcomes. Table 4 shows care coordination activities that led to good or poor coordination and their proportion to all of the care coordination activities identified in Table 1.

Table 4: Number of care coordination activities that lead to good or poor coordination

Coordination activities	Interdependencies							
	F		SR		F&SR		Total	
	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Communication	11 (16%)	5 (7%)	14 (14%)	10 (10%)	9 (43%)	2 (10%)	34 (17%)	17 (8%)
Monitoring	0	2 (15%)	0	0	0	0	0	2 (15%)
Communication & Monitoring	3 (15%)	4 (20%)	0	3 (33%)	5 (36%)	2 (14%)	8 (19%)	9 (21%)
Total	14 (14%)	11 (11%)	14 (12%)	13 (12%)	14 (40%)	4 (11%)	42 (16%)	28 (11%)

Note: Good or poor outcomes were not available for all care coordination activities that I identified in Table 1. Percentages show the proportion of numbers in Table 4 to those in Table 1. F= Flow, SR=Shared Resources, Good=Good coordination, Poor=Poor coordination

Care coordination activities with flow interdependency can lead to good coordination when the output of the producer activity flows to the consumer activity. In the 14 communication/ monitoring-flow activities that lead to good coordination, the output of the producer activity flows to the consumer activity and the consumer activity is performed. For example, a TOC care

manager realizes a patient who was discharged from hospital to home is not doing well. She gets an order (output) from a physician for the home health agency (producer activity), and arranges home health services for the patient (consumer activity).

On the other hand, in 7 of the 11 communication and/or monitoring and flow activities that lead to poor coordination, the output of the producer activity does not flow to the consumer activity and therefore the consumer activity is not performed. For example, a patient calls a PCP office with a problem. The patient does not hear back because the office staff did not transfer the call to the outpatient care manager. In the other 4 communication and/or monitoring and flow activities, the output of the producer activity did flow to the consumer activity, but the receiver of the output decided not to proceed with the consumer activity. Individual characteristics of the receiver of the output resulted in the consumer activity not being performed, which lead to poor coordination. For example, an outpatient care manager informs a patient of nursing home arrangement, but the patient refuses to go to the nursing home and instead goes home and faces challenges.

In the 14 communication flow and shared resources activities that lead to good coordination, a resource is shared between a producer and a consumer activity and the consumer activity is performed. For example, a TOC care manager talks to an inpatient nurse and an inpatient physician to inform them that a patient is allergic to a medication (shared resource) on the discharge list and they were able to change the medication (flow). On the other hand, in the 4 communication flow and shared resources activities that lead to poor coordination, either the resource was not shared or the consumer activity did not occur due to individual characteristics of patients. For example, an outpatient care manager is not able to get a clear understanding of a patient's status from the information a nursing home nurse provides to her (shared resource). The outpatient care manager then asks a PCP to make a visit to nursing home and the physician realizes the patient was being treated for the wrong diagnosis (flow).

In the 14 communication/monitoring and shared resources activities that lead to good coordination, a resource is shared between activities and therefore coordination goes well. For example, a home health nurse has a question about a patient's medication; she calls the physician or care manager to obtain the medication information (shared resource). On the other hand, in the 13 communication/monitoring and shared resources activities that lead to poor coordination, the resource is not shared between the activities that needed the resource and coordination goes poorly. For example, a home health nurse goes to a patient's home and no one opens the door; a neighbor tells her that the patient was admitted to the hospital.

Appendix 10: Detailed results for RQ2

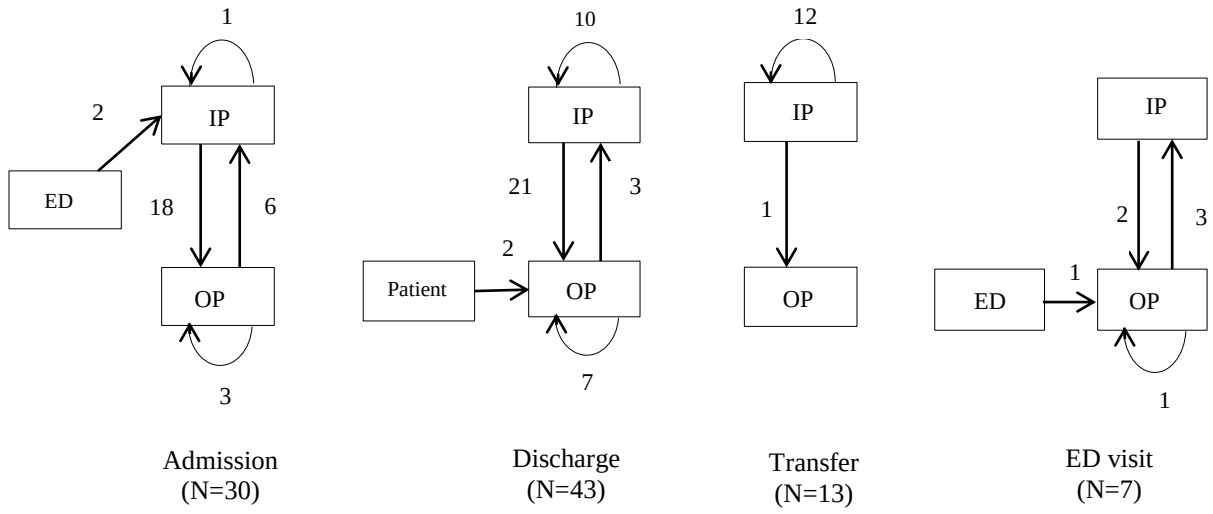
I identified a total of 93 communication events in four transition stages: 30 (32%) admission, 43 (46%) discharge, 13 (14%) transfer and 7 (8%) ED visit (see Table 1).

Table 1: Communication events identified at each transition stage

Transition stage	# of communication events
Admission	30
Discharge	43
Transfer	13
ED visit	7
Total	93

Figure 1 shows a visual representation of communication events at each transition stage: patient hospital admission, discharge, transfer to another hospital, and ED visit. These communication events occur between healthcare professionals in inpatient setting, outpatient setting, ED, and patients at home.

Figure 1: Communication events between different settings at each transition stage



Note: The arrows represent communication events and boxes show setting of communicators. For example, an arrow from OP to IP means a healthcare professional in the OP setting notified healthcare professional in the IP setting. IP: inpatient, OP: outpatient, ED: emergency department, Patient: patient at home. Transfer refers to transfer of patients from one hospital to another hospital.

Admission (N=30 events)

Communication about patient admission to hospital is performed across people from different care settings including inpatient, outpatient and ED. Of the 30 communication events about patient admission, 18 (60%) are between healthcare professionals in IP to OP setting, 6 (20%) are from healthcare professionals in OP to IP setting, 3 (10%) between healthcare professionals in OP setting, 2 (7%) from healthcare professionals from ED to IP setting and 1 (3%) between healthcare professionals in IP setting. See Table 2 for details.

Table 2: people involved in patient admission notification

Category	People involved	Frequency	CM software	CM software + Email	CM software/ IM	Phone	IM+ Phone	EHR	Email/ IM	Face-to-face
IP to OP	Hospital staff, Clinic staff	1						1		
	IP CM->MMA, OP CM	1	1							
	IP CM, GHP CM	3			1			1	1	
	IP CM, OP CM	10	5	1		2	2			
	IP CM, TOC CM	1				1				
	Hospital staff, OP MD	1						1		
	IP RN CM, OP CM	1				1				
	Total	18	6	1	1	4	2	3	1	
OP to IP	Clinic staff, IP CM	1				1				
	OP CM, IP CM	3				3				
	TOC CM, IP CM	1							1	
	MMA, IP CM	1	1							
	Total	6	1			4			1	
OP to OP	Clinic staff, OP CM	1								1
	OP MD, OP CM	1						1		
	MMA, OP CM	1	1							
	Total	3	1					1		1
ED to IP	ED Nurse, IP CM	1								1
	ED Staff, IP CM	1				1				
	Total	2				1				1
IP to IP	IP SW, IP CM	1								1
Total		30	8	1	1	9	2	4	2	3

Communication events about patient admission between IP and OP settings are performed using different media depending on the content and purpose of the communication.

- CM software (6): is used by IP CMs to provide a simple notification to OP CMs about a patient's admission to hospital. There is a lag in notification using CM software; by the time OP CMs receive the notification, they may already be aware of patient admission. No response is expected when using CM software.
    - CM software + Email (1): email is used in advance of CM software to provide a heads-up about patient admission.
    - CM software/IM (1): if an OP CM has IM set up, IM may be used instead of CM software.
- Phone (4): is used when in addition to a patient's admission notice, additional information about the patient needs to be communicated from IP to OP setting; especially if there is important or unusual information about the patient. Also, phone provides an opportunity for people in both IP and OP settings to exchange information (e.g. medication changes, doctor visits) about the patient.
- EHR (3): is used by IP CMs for notifying a OP CM about a patient's admission. Additional information such as a patient's family support and need for placement in a facility may be communicated in the message. Staff at family medicine clinic receive a report through EHR when their patients are admitted to a hospital; they then follow up with a phone call.
- Instant Messaging (IM) is used by IP CMs to notify OP CMs about a patient's admission. IM is also used by OP CMs to ask IP CMs if their patient is in the hospital. IM allows for a quick notification and gives the opportunity to get quick a response.
    - IM+ Phone (2): IM is followed by a phone call from an IP CM to communicate additional patient information to an OP CM.
    - Email/IM (1): email can be used by an IP CM in place of IM to notify a GHP CM of patient admission.

Communication events about patient admission between OP and IP settings are performed using phone, email/IM or CM software.

- Phone (4): is used by OP CMs to notify IP CMs that a patient is coming to the hospital. OP CMs also use phone to inform IP CMs about a patient that has been admitted to the hospital, but IP CMs had missed.
- Email/IM (1): email or IM are used by TOC CMs to notify IP CMs about a patient's admission. IP CMs respond and confirm that they will follow the patient.
- CM software (1): is used by MMAs to notify IP CMs about a patient's admission along with admission date and diagnosis.

Communication events about patient admission within OP settings are performed using CM software, EHR or face-to-face.

- CM software (1): is used by MMAs to notify OP CMs about a patient's admission. The notification has a lag and OP CMs may already know about patient admission.
- EHR (1): is used by OP physician to run a list of patients admitted to the hospital for OP CM.
- Face-to-face (1): is performed when a clinic staff notifies an OP CM about a patient's admission. Being in the same office makes face-to-face communication possible.

Communication events about patient admission between ED and IP setting are performed face-to-face or using phone.

- Face-to-face (1): ED nurses notify an IP CM about a patient that will later be admitted and followed by the IP CM.
- Phone (1): is used by ED staff to notify an IP CM about a possible admission and ask the IP CM to come see a patient and see if admission can be prevented. Phone enables a request in addition to the notification.

Communication event about patient admission with IP settings is performed face-to-face.

- Face-to-face (1): an IP SW notifies an IP CM about a patient's admission when she sees her.

Discharge (N=43 events)

Communication about patient discharge from hospital is performed across people from inpatient and outpatient settings and patients at home. Of the 43 communication events about patient admission, 21 (49%) are from healthcare professionals in IP to OP setting, 10 (23%) between healthcare professionals in IP setting, 7 (16%) between healthcare professionals in OP setting, 3 (7%) from healthcare professionals from OP to IP setting, and 2 (5%) from patients/families to healthcare professionals in OP setting. See Table 3 for details.

Table 3: people involved in patient discharge notification

Category	People involved	Frequency	CM software	CM software+	Phone	IM	Fax	Fax+ EHR	EHR	Email/ IM	Face-to-face
IP to OP	IP CM, OP CM	8	1	1	5						
	IP CM, TOC CM	3			2	1					
	Hospital staff, OP MD	2					1	1			
	Hospitalist, OP MD	2			2						
	IP CM->MMA, OP CM	2	2								
	IP CM, GHP CM	2	1							1	
	Hospital staff, OP RN	1			1						
	Hospital staff, GHP CM	1							1		
	IP RN CM, OP CM	1			1	1					
	Total	22	4	1	11	2	1	1	1	1	
IP to IP	Hospital staff, IP CM	1									1
	IP RN CM, IP SW	1									1
	IP SW, IP CM	5									5
	IP SW, IP RN CM	2									2
	Total	9									9
OP to OP	Clinic staff, OP CM	3									3
	SNF SW, OP CM	2			2						
	MMA, OP CM	2	2								
	Total	7	2		2						3
OP to IP	GHP CM, IP CM	2			2						
	OP CM, IP CM	1				1					
	Total	3			2	1					
Patient at home to OP	Patient/Family, OP CM	1			1						
	Patient/Family, OP RN	1			1						
	Total	2			2						
Total		43	6	1	17	3	1	1	1	1	12

Communication events about patient admission between IP and OP settings are performed using different media depending on the content and purpose of the communication.

- Phone (11): is used when, in addition to a patient's discharge notice, additional information about the patient needs to be communicated. IP CMs use phone to inform OP CMs or TOC CMs about a patient's discharge, provide additional information about the patient (e.g., appointment, language) including anything unusual about the patient. Hospital staff use phone to inform an OP nurse about a patient's need for an appointment. Phone is also used by hospitalists to inform OP physicians about patients' discharge and any issues about the patients (e.g. social issues) that OP physicians should be aware of.
- CM software (4): is used by IP CMs to send a simple notification to OP CMs (through MMAs) about patient discharge. An IP CM also sends CM software to inform a GHP CM about a patient's discharge; the IP CM assumes if the GHP CM is not following that patient, she/he would still inform the right care manager.
- IM (2): is used by an IP CM to inform an TOC CM about a patient's discharge and the patient's need for an appointment. An IP CM uses IM to inform an OP CM to that a patient will not be discharged that day.
- Email or IM (1): an IP CM uses email or IM to inform an GHP CM about a patient's discharge to home. If there are any unusual information about the patient, then she uses phone.
- CM software + Email (1): an IP CM sends an email to inform an OP CM about a patient's discharge; the IP CM follows with a CM software. The reason for the initial email heads-up is that there is a lag associated with CM software.
- Fax (1): an OP physician gets discharge summary through fax from the hospital and knows a patient is discharged.
- EHR (1): an GHP CM gets notification through EHR that a patient is discharged; she then monitors the discharge instructions and follows up with the patient in 1-2 days.
- Fax and EHR (1): an OP physician gets a discharge summary from the hospital both on paper and on the computer and knows a patient is discharged.

Communication events about patient admission within IP settings are performed face-to-face.

- Face-to-face (8): IP SWs or hospital staff tell IP CMs when anticipating discharge; this helps IP CMs prepare. IP SWs will tell IP CMs about patients being discharged and talk about patient needs (e.g. home health). For patients with IV antibiotic IP CMs tells IP SWs about patients' discharge. This method depends on the people seeing each other.

Communication events about patient admission within OP settings are performed face-to-face, using CM software or phone.

- Face-to-face (3): clinic staff receive discharge summary from hospital and inform OP CMs that a patient has been discharged. Being in the same office allows face-to-face communication.
- CM software (2): MMAs send CM software to OP CMs to inform them of patient discharge. There is a delay with this tool, therefore sometimes OP CM gets the notice 2-3 days after patient has been discharged.
- Phone (2): an OP CM asks an SNF SW in advance to inform her when a patient is being discharged. A SNF SW calls an OP CM to inform about patient discharge from nursing home to home. The SNF SW leaves a message if the OP CM does not pick up the phone.

Communication events about patient admission between OP and IP settings are performed

- Phone (2): a GHP CM calls an IP CM to inform her about a patient's discharge. The GHP CM knows patient is discharged before the IP CM, because hospital faxes discharge summaries to PCP offices and the IP CM was out of office in the morning and not aware of a patient's discharge. Phone conversation provides the opportunity to communicate a request in addition to discharge notification. For example, a GHP CM calls an IP CM and talks about a patient's discharge and asks IP CM to help with filling the patient's prescription in a timely manner.
- IM (1): an OP CM sends IM to an IP CM to ask if a patient is still in the hospital or discharged.

Communication events about patient admission between patients at home to healthcare professionals in OP setting are performed using phone.

- Phone (2): Patients or families sometimes call an OP CM and let her know a patient has been discharged. An OP nurse knows a patient has been discharged when the patient calls to make an appointment as directed in the discharge summary; the OP nurse then makes an appointment for the patient.

Transfer (N= 13)

Communication about patient transfer to another hospital is performed among healthcare professionals in the IP and OP setting. Of the 13 communication events on patient transfer, 12 (92%) are between healthcare professionals in IP settings and 1 (8%) is between health care professionals in IP to OP Setting. See Table 4 for details.

Table 4: people involved in patient transfer notification

Category	People involved	Frequency	CM software	Phone	Email+ Phone	Email/IM	EHR/ Pager	Face-t-Face
IP to IP	IP CM, IP CM	8	2	2	2	1	1	
	IP CM>MMA, IP CM	2	2					
	Hospital staff, IP CM	1						1
	ICU Nurse, IP CM	1						1
	Total	12	4	2	2	1	1	2
IP to OP	IP CM, OP CM	1	1					
Total		13	5	2	2	1	1	2

Communication events about patient transfer within IP settings are performed using different media depending of the content and purpose of their communication.

- CM software (4): IP CMs send CM software to other IP CMs to inform them a patient is being transferred to their hospital. FYIs can come through the MMAs.

- Face-to-Face (2): an ICU nurse tells an IP CM that a patient is going to be transferred to another hospital. If a patient gets transferred to a different hospital during night or over the weekend, hospital staff tell a IP CM the after, and then she informs IP CM at the destination hospital. This method depends on the two people seeing each other.
- Email and phone (2): an IP CM emails another IP CM to inform her about a patient being transferred. In the email, she asks the IP CM to call her so she can provide more information.
- Phone (2): IP CMs call other IP CMs to inform them about a patient's transfer to their hospital.
- Email or IM (1): an IP CM sends an email or IM to inform an IP CM at another hospital that a patient is being transferred. This notification is done by IP CMs in certain hospitals, not all hospitals. IM is used when the IP CM at the destination hospital has access to IM.
- EHR message or pager (1): an IP CM sends a message through EHR or uses pager to inform an IP CM at another hospital that a patient is being transferred.

Communication event about patient transfer between IP to OP setting is performed through CM software. An IP CM sends CM software to an OP CM to inform her a patient has been transferred from one hospital to another.

ED visit (N=7)

Communication about patient visit to ED is performed across people from different care settings including IP, OP and ED. Of the 7 communication events about patient admission, 3 (43%) are from healthcare professionals in OP to IP setting, 2 (29%) healthcare professionals in IP to OP setting, 1 (14%) from healthcare professionals in ED to OP setting, and 1 (14%) between healthcare professionals in OP setting. See Table 5 for details.

Table 5: people involved in patient ED visit notification

Category	People involved	Frequency	Phone	Phone/ IM	Face-to-face
OP to IP	Clinic staff, IP CM	1	1		
	GHP CM, IP CM	1		1	
	OP CM, IP CM	1	1		
	Total	3	2	1	
IP to OP	IP CM, OP CM	2	2		
ED to OP	ED CM, TOC CM	1	1		
OP to OP	Clinic staff, OP CM	1			1
	Total	4	3		1
Total		7	6		1

Communication events about patient ED visit between OP to IP setting are performed using phone or IM.

- Phone (2): is used by clinic staff to inform a IP CM about a patient being sent to ED. Clinic staff know the IP CM so they feel comfortable calling her. Phone is also used by an OP CM to inform an IP CM about a patient being sent to ED, and ask the IP CM to see the patient. The IP CM sees the patient to possibly prevent an admission.
- Phone or IM (1): a GHP CM calls or sends an IM to an IP CM to inform her about a patient being sent to ED, and asks the IP CM to notify her if the patient gets admitted. Phone and IM provide the opportunity to ask a request in addition to notification about patient ED visit.

Communication event about patient ED visit between IP to OP setting is performed using phone. An IP CM calls an OP CM to inform her about a patient being sent to ED. The IP CM makes this call to the OP CM after knowing the reason why patient is in ED.

Communication event about patient ED visit between ED and OP setting is performed using phone. An ED CM calls a TOC CM to inform her about a patient being in ED. The ED CM has access to CM software and can see that the patient has a TOC CM. The TOC CM mentions that this notification is a hit and miss and does not always occur.

Communication event about patient ED visit within OP setting is performed face-to-face. Clinic staff inform an OP CM about her patient being sent to ED. Being in the same location enables clinic staff and the OP CM to communicate face-to-face.

Comparison between Admission and Discharge

I compared the different pairs of communicators for admission and discharge using the chi-square test (see Table 6).

Table 6: Comparison between pairs of communicators for admission and discharge

Transition stage	IP-OP	OP-IP	OP-OP	ED-IP	IP-IP	Patient-OP	Total
Admission	18	6	3	2	1	0	30
Discharge	21	3	7	0	10	2	43
Total	39	9	10	2	11	2	73

The result showed that there is significant difference (*p* value=0.031) between distribution of pairs of communicators in admission and discharge notification.