Chapter 15
Health IT-Enabled Care Coordination and Redesign in Ambulatory Care

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15.1 Introduction

Studying workflow and health information technology (IT) adoption is complex because there are many contributing factors and confounders. Research attention to the study of workflow has intensified in the U.S. since the rollout of the meaningful use (MU) program by the Office of the National Coordinator for Health IT (ONC) in 2009. The mounting interest in better understanding clinical workflow in the context of health IT implementation reflects a realization from early pioneer health IT studies, which is that factors such as site leadership, workflow optimization prior to automation, team communication, and attention to many details of practice and health IT design and use, can lead to successful adoption of new technology when aligned, or can limit the adoption if gaps are present and remain unaddressed.

The misalignment between workflow and health IT may arise from many contributing factors. These include mismatch between health IT design and the workflow that predated the implementation, insufficient training of users, and inexperienced technical staff responsible for configuring health IT. In addition, health IT often brings together changes in clinical and administrative activities, such as how clinical activities are documented and how billing processes are managed. These, and other sociotechnical challenges, add to the complexity of health IT adoption and implementation research.

Subtle configuration and implementation-related decisions can hurt or help with user experience, such as how users are assigned to system-defined user roles with different levels of access privileges. For example, a mid-level role such as a physician

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assistant or nurse who functions as a population health manager may perform both clinical and administrative tasks, which doesn't always "fit" the roles pre-defined in health IT systems. Flexible health IT design is therefore needed to accommodate unanticipated task sequences, workflows, and roles. Decisions on how to configure systems for the local context may also introduce usability or workflow challenges, and also may limit the flexibility of the software as clinical redesign takes place.

Many decisions related to user training may also impact health IT adoption. For example, training that uses simulated test environments may not correspond closely to the live environment, although differences may not be apparent until after go-live. Also, many of the more technical users, especially clinicians, may be paired with trainers who lack specific skillsets needed to train certain users. Finally, the generic, *one-size-fits-all* design, which is popularly found in today's health IT systems, may be insufficient for supporting complex tasks when there is a significant amount of variation in how they are performed in day-to-day clinical practice.

15.2 Background

15.2.1 Gaps in Prior Research on Workflow

The widespread adoption of health IT to manage electronic patient data and support care delivery has expanded the role that technology plays during work systems redesign in healthcare. However, the anticipated benefits of health IT are difficult to achieve unless implementation and workflow challenges are identified and addressed (Ash et al. 2009; Blumenthal 2011; Dorr et al. 2007; Novak et al. 2012; Holden et al. 2013). Health IT–workflow interactions are best understood through a human factors and sociotechnical framework (Novak 2010), but large gaps in systematic research of ambulatory care workflow still exist (Carayon et al. 2010).

In 2010, the U.S. Agency for Healthcare Research and Quality (AHRQ) published a comprehensive literature review study that looked into existing research and evidence about the impact of health IT on workflow, its linkage to clinician adoption, and its linkage to the safety, quality, efficiency, and effectiveness of patient care delivery. The study showed evidence of variable quality, little generalizability to non-academic and ambulatory settings, and limited focus on the sociotechnical context of health IT implementation including potentially conflating or mediating factors such as training, technical support, and organizational culture (Carayon et al. 2010). Existing research reviewed in the AHRQ study also did not address redesign of ambulatory care settings, though this is an important aspect of health systems change.

In addition, the AHRQ study identified significant gaps in understanding the interactions between health IT and workflow, and advised that more systematic research was needed, both to establish causal relationships and to produce highly generalizable knowledge in the study of health IT and workflow interactions

(Carayon et al. 2010). Accordingly, the study that we describe in this chapter was designed to address two major gaps in the literature:

- **Rigorous research focused on workflow**. This study used a combination of methods (Carayon et al. 2012) specifically designed to understand workflow in the context of a work system implementing new health IT. These adapted methods were implemented by experts in sociotechnical systems research in partnership with clinical subject matter experts in order to provide an understanding of workflow phenomena that are typically ignored or underspecified in prior studies, including: adaptation of health IT, the role of health IT in team-based work, and the coevolution of health IT and workflow.
- **Attention to sociotechnical context**. This study approached workflow as an interactive sociotechnical work system of: (1) people; (2) tools, technologies, and other artifacts; (3) tasks and task characteristics; (4) organizational structures and characteristics; and (5) the surrounding physical, social, and political environment. Data collection and analysis focused on these five factors, alone and in interaction, and how they relate to (for example, constrain or enable) the studied work processes. Attention to the sociotechnical aspects permitted this study to both describe this context and allow comparisons to other contexts. It also permitted the research team to understand what specific contextual factors influenced workflow-related phenomena—for example, the circumstances in which implementing the same health IT system in two or more settings might lead to divergent workflow changes, and why.

15.2.2 Theoretical Framework

The study's theoretical framework was informed by two compatible models that have been applied to workflow research: the adapted SEIPS (Systems Engineering Initiative for Patient Safety) model (Carayon et al. 2006; Karsh et al. 2006; Carayon 2009) and the Workflow Elements Model (WEM) (Carayon et al. 2012; Unertl et al. 2010), depicted in Figs. 15.1 and 15.2. The SEIPS model defines the work system as the interaction of people, tools/technology, tasks, organization, and environment. This work system (structure) shapes workflow (process) that in turn shapes patient and clinician outcomes. The structure-process relationship requires that workflow be studied in the context of the interacting work system. In addition to understanding workflow as process steps or patterns, it must be specified who is involved or not involved (**people**), what artifacts are used or not used (**tools/technologies**), what characteristics such as goals or task demands constrain work (**tasks**), what structures or policies are in place that govern people and processes (**organization**), and where the work takes places (**environment**). This adapted model shown in Fig. 15.1 builds on the SEIPS and related systems models to illustrate workflow as the product of a sociotechnical work system that is transformed by new health IT as well as adaptations over time.

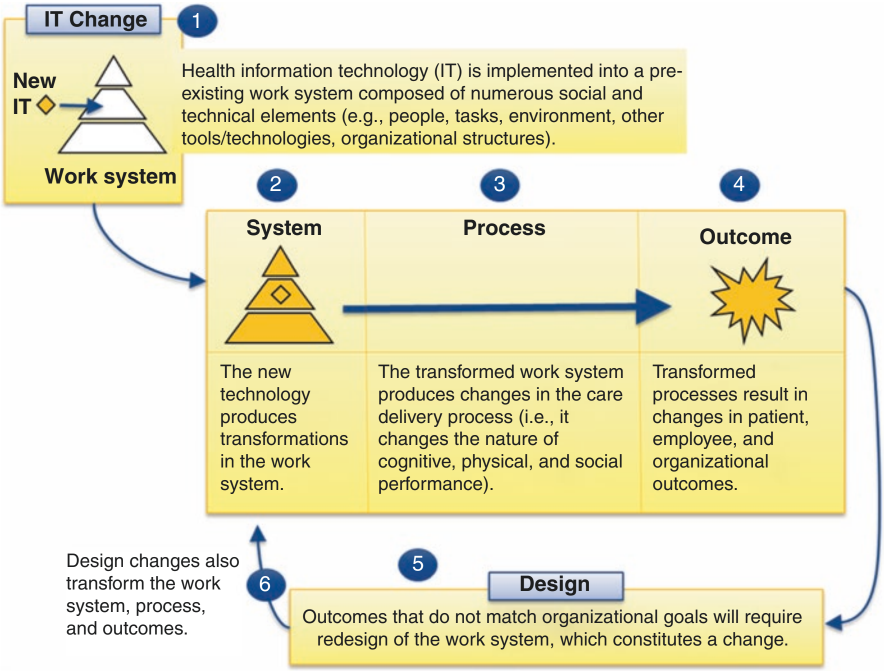

Fig. 15.1 The Adapted SEIPS Model. Source: Holden et al. (2011). Note: This graphic is reprinted under a Creative Commons license

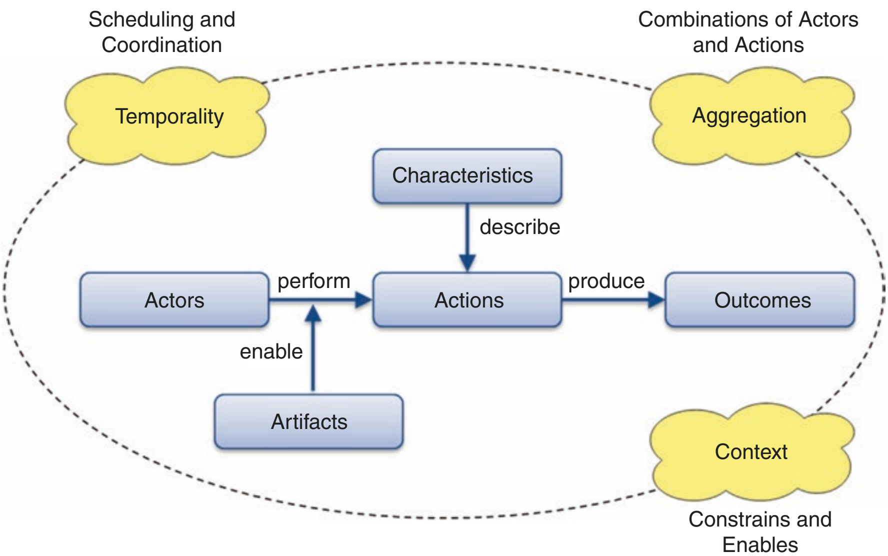

Fig. 15.2 Workflow Elements Model. Source: Unertl et al. (2010) with permission from Oxford University Press

WEM is a broad synthesis of prior workflow research and adds to and refines how one might apply SEIPS generally to the study of workflow (Carayon et al. 2012). WEM specifies three pervasive properties of workflow that shape outcomes or the end products of workflow. First, workflow is dynamic (**temporality**): it occurs across time, changes from moment to moment, depends on a context that may change over time, and often emerges from the activity of individuals and groups working asynchronously in different locations. Second, workflow is collective (**aggregation**): work is carried out by multiple individuals as well as collectives working separately or in concert, synchronously or asynchronously, and toward goals that may converge or diverge. Processes, too, are subject to aggregation and can be delineated into tasks or patterns or seen in combination or as emergent properties of work. Third, workflow occurs in **context**, including work system elements—such as people and technologies—and any other factors that constrain or enable workflow. Examples of contextual factors not explicit in SEIPS include extra-organizational culture, standards, legislation, pressures, and workforce characteristics (Karsh et al. 2006).

The two models in combination guided the data collection of this study in the following ways:

1. Both models promote capturing and analyzing data on sociotechnical system factors (such as people, technologies, and task characteristics) that are relevant to studied processes and steps or patterns.
2. SEIPS specifically promotes capturing and analyzing data on people, tools/technology, task, organization, and environment factors—as well as interactions between the factors—related to parts of or whole processes.
3. WEM specifically promotes capturing and analyzing data on temporality, aggregation, and contextual properties of parts of or whole processes.
4. Both models promote a focus on processes and related work system factors and pervasive properties that shape key outcomes such as successful, coordinated health and disease management.

15.3 Our Study

15.3.1 Health IT Studied and Empirical Setting

The My Health Team at Vanderbilt (MHTAV) program was initially developed in 2010 by the Vanderbilt Medical Group to be an innovative, ambulatory health care delivery model for a small group of patients with three chronic conditions, diabetes, hypertension, and congestive heart failure, among pilot physicians in one clinic. Vanderbilt received external funding through a U.S. Centers for Medicare & Medicaid Services (CMS) innovations contract in 2012 to greatly expand the program with revised goals: to improve chronic disease management, care coordination, and transition management for all Vanderbilt patients with the three chronic medical conditions.

The expanded MHTAV program was centrally administered and implemented, although the implementation of the program varied somewhat across clinics based on the experience of the care coordinators and the composition of the clinical teams. The MHTAV program included intensified patient engagement and dedicated care coordinators (CCs). CCs were registered nurses who helped coordinate care for patients.

Major IT system components were developed or used in support of care coordination activities, including: (1) the Vanderbilt electronic health record (EHR) system (StarPanel), (2) cross-patient dashboards for diabetes, hypertension, and congestive heart failure, (3) worklists for use by CCs, (4) a shared view of the patient's plan of care (POC) among clinical staff, (5) alerts and reminders related to care coordination activities, (6) the disease control form, (7) patient portal secure messaging, (8) an interactive voice response (IVR) system, (9) the clinic scheduling system, and (10) online patient education and materials.

A number of health IT components were created or used primarily for MHTAV, including the dashboards, worklists, the POC, and the IVR system, collectively referred to as My Health Team (MHT) tools or the MHT system. A key goal of the MHT system was to support structured, bidirectional, and closed-loop communication among members of the care team, including the patient and caregivers. In the context of MHTAV, the providers and clinic nurses provided direct care to patients. CCs managed the MHTAV panel of patients and were supported by MHTAV medical assistants who assisted the CCs with patient education, collection and summaries of patient home monitoring data (blood pressures and blood sugars), and administrative tasks. MHT tools included a range of information that could be viewed for an individual patient or at the population level. At the patient level, this included demographic information, the patient's condition or disease, and a POC. At the population level, a dashboard showed aggregated statistics for selected indicators. Care coordinator activities were driven by a worklist which showed patients with alerts that were either clinically driven (such as an elevated home blood pressure reading) or process driven (such as a patient who was due for an annual foot exam).

The empirical study involved six study site teams in five office locations (see Table 15.1). These included a single on-campus medical office (medium-sized; 35 part-time clinicians) and four off-campus primary care offices (small; 2–11 clinicians). All of them are located in Tennessee and staffed with providers (physicians, nurse practitioners), clinic nurses, clinic secretaries, and clinic medical assistants.

15.3.2 Methods

15.3.2.1 Study Design

A formal mixed-methods approach was designed, employing direct observation, patient and staff interviews, surveys of staff and patients, artifact and spatial data collection, software use monitoring, and impact on process outcomes for the six site

Table 15.1 Study sites

Site team	Attending MDs	Resident MDs	NPs	Setting	MHTAV adoption[a]	CC proximity
1	35	93	0	Urban	April 2010	In separate office, 5 days/week
2	2	0	0	Rural	March 2014	On-site, 2 days/week
3[b]	4	0	3	Urban	November 2013	On-site, 5 days/week
4	10	0	1	Suburban	October 2012	In office on different floor, 5 days/week
5	11	13	0	Suburban	May 2013	In separate office, 5 days/week
6[b]	4	0	3	Urban	November 2013	On-site, 5 days/week

MD physician, *NP* nurse practitioner, *MHTAV* My Health Team at Vanderbilt, *CC* care coordinator
[a]At initial observation, MHTAV site teams were already Live at sites 1, 4, 5; MHTAV-adopting site teams 2, 3, and 6 began use of MHTAV after initial study observation
[b]Two different teams were observed at the same clinic

teams at primary care clinics in different phases of adopting MHTAV. Data collection occurred over a 12-month period to capture health IT–workflow interactions over time, and across clinics in various implementation phases.

Care coordinators in this study were licensed as RNs who functioned in the CC role rather than the clinic nurse role, and worked with a care team composed of a provider (i.e., a physician or nurse practitioner), a clinic nurse (i.e., a registered nurse [RN] or licensed practical nurse [LPN]), a medical assistant (MA), and sometimes a scheduler.

Three site teams were already "live" with MHTAV and a CC at the start of the study, and three site teams were introduced to the CC and MHTAV program after the 12-month observation period had begun. Observations and data collection occurred at time zero, after 6 months, and after 12 months for each site team.

CCs in the study were primarily focused on identifying and managing hypertension-associated risks in their panel of patients, and worked to mitigate those risks and help their patients reach blood pressure goals, enabled by health IT. In the last few months of data collection, use of the MHT tools for diabetes-associated risk was added.

Recruitment of the six site teams occurred following approval of the study by both RTI's and Vanderbilt's Institutional Review Boards (IRB).

15.3.2.2 Data Collection and Analysis

Data collection activities included: (1) project orientation meeting with staff from each clinic site, (2) direct observation of staff work, (3) individual staff interviews, (4) individual patient interviews, (5) staff surveys, and (6) patient surveys. In addition, the Vanderbilt University Medical Center IT department provided utilization data for the MHT system, and diabetes process outcome data were obtained for the providers participating in the study. These data collection methods are summarized in Table 15.2.

Table 15.2 Data collection activities

Data collection activity	Source of data	Data description
1. Staff orientation meeting	Practice staff	Notes of practice staff discussion of practice operations, including health IT support of care coordination issues and challenges
2. Direct observations of care coordination	Care coordinator (if identified); patients; other individuals in the practice responsible for care coordination key workflows including: (a) registering patients, (b) sharing care plan, (c) handling alerts and reminders, (d) compiling and interpreting data from at-home monitoring, and (e) communicating with patients between visits.	Field notes of workflow steps, information flow steps, and other information required to create workflow and information flow models; description of health IT components and capabilities relating to care coordination
3. Staff semi-structured interviews	Practice staff participating in direct observations	Responses to interview guide questions gathered from practice staff
4. Patient semi-structured interviews	Patients with diabetes contacted through direct observation or introduced by their physician	Responses to interview questions from patients
5. Staff surveys	Practice staff	Responses to modified Technology Acceptance Model (TAM) survey (Davis 1989); modification includes responses to additional survey questions focusing specifically on care coordination
6. Patient surveys	Patients	Responses to Patient Activation Measure (PAM) 13-item instrument (Hibbard et al. 2004); and Summary of Diabetes Self-Care Activities (SDSCA) 10-item instrument
7. Artifact and spatial data collection	Researcher or study participant	Items identified as relevant by researchers during direct observations; examples include: a template of a shared care plan; an appointment reminder postcard, or printed lists used by care coordinators to monitor their work each day
8. Software use monitoring	Data extracts developed for My Health Team (MHT) reporting	Audit logs

Meeting notes and narrative data were entered and analyzed using Dedoose™ through a process of (1) open coding, (2) axial coding, and (3) workflow modeling. Dedoose is a web-based qualitative and mixed-methods data analysis cross-platform application designed to support collaborative data analysis activities. To further support the analysis, we scored staff and patient survey responses and tracked software module use. Quantitative and qualitative data, together, supplemented one another to help us identify complementary themes, resolve conflicting findings, and provide rich detail to support conclusions about health IT–workflow interactions—in general and across implementation phases.

15.3.2.3 Coding

During Open coding, data captured after each observation period were reviewed to identify coding elements for "chunks" of textual data, and the coding structure was refined over time as observations were added and higher-level themes were identified.

Next, axial coding was performed to add depth and structure to the constructs (codes) from the open coding phase, synthesizing lower-level constructs into a more integrative theory (Saldaña 2009). During axial coding, all qualitative data were reviewed again and categorized according to the SEIPS model combined with the WEM. The combination of SEIPS and WEM provided the structure for assigning data and codes to the elements shown in Table 15.3.

Applying this framework to hypertension care, primary care providers (actors) perform preventive care and screening procedures (actions) during routine patient care visits, leading to a patient being current on all recommended preventive health care services (outcomes). Health care providers use artifacts in accomplishing their work, including EHRs, paper forms, and paper education materials. Characteristics describing the actions include descriptors such as "routine," "screening," "preventive," and "recurrent." The work of routine preventive care takes place in a specific sequence on a schedule defined by evidence-based guidelines. Routine preventive care work also occurs during days the clinic is open (temporality) and relies on administrative staff and nurses for assistance and information contributions from other health care providers to develop thorough understanding of patient status (aggregation). Permeating all of the workflow processes is the context of the work—the health care organization, the physical space available, the family and support structure for the patient, and the organization's policies and requirements.

15.3.2.4 Stage 3: Workflow Modeling

The final element of qualitative data analysis involved development of graphical representations of workflow processes, called workflow models. The workflow models were similar to flow charts but contained more detailed documentation of work practices and capture actual work processes as opposed to idealized ones.

Table 15.3 Workflow elements model Categories guiding axial coding

Element	Definition	Examples from data
People (actors)	Individuals engaged in work	Care coordinator, medical assistant, physician, clinic nurse, patients
Process (actions)	Steps that actors take to accomplish work	Care coordinator work, medical assistant work, patient work
Outcomes	End results of work	Diabetes adherence, patient education
Tools and technologies (artifacts)	Tools used in work	Message Basket, the EHR, MHT system, Plan of Care Support tab
Tasks (action characteristics)	Descriptions of the work	Patient education, response to alerts/reminders, personal interactions with patients
Temporality	Time-based factors, including scheduling and coordination	Alerts/reminders, patient appointment times, meeting patients in clinic
Aggregation	Collective work across actors and actions, including collaboration	Coordination with multiple providers (including external), coordination with call center, coordination with clinic nurses
Context	Setting for the work, which constrains and enables work activities	Spatial proximity to clinic/providers, technology constraints
Interactions among elements	Phenomena that are the result of interactions among the elements described above	Creation/modification of Plans of Care

The modeling process is based on concepts from soft systems methodology (Checkland and Scholes 1999) and hierarchical task analysis (Shepherd 2001). Similar to hierarchical task analysis, during model generation, each larger task is divided into subtasks and each subtask is further divided until a detailed diagram of workflow is generated. For example, the overall work process this project studied is care coordination. Subtasks involved in this overall task may include physicians taking notes in the EHR system, nurses measuring a patient's vital signs, CCs contacting patients directly via phone or e-mail, or many other subtasks. The subtask of CCs contacting patients directly may be further broken down into steps taken to identify patients requiring contact, obtaining contact information, contacting the patient, discussing relevant information with the patient, and documenting the outcomes of the discussion with the patient. All subtasks are captured in the graphical workflow models.

Using the output of earlier data analysis stages, researchers identified the overall flow of CC work and each sub-process involved in it and manually developed workflow models. Workflow models represent physical space, artifact use, roles, decision points, process variation, organizational policy, and other aspects of workflow related to CC work as necessary. For example, the support activity of "Search for Information" was depicted using a diagram that highlighted information flow and artifacts, rather than focusing on physical space, given that most of the activity took place at the CC desk using the computer, notepad, and phone. The modeling process highlights the specific role that health IT plays in CC work and the impact of new health IT functionality on workflow.

15.3.2.5 Staff Survey Data

Survey data collected from each individual who was interviewed was used to consistently capture additional user information beyond qualitative data such as those obtained through observations and interviews. Responses to the adapted Technology Acceptance Model (TAM) survey were used to evaluate user perceptions and acceptance of technology (Davis 1989). Specifically, the TAM measure includes ease of use and usefulness. Descriptive statistics (for example, mean, standard deviation, and median) were calculated using Microsoft Excel, adding context in interpreting staff perceptions related to health IT.

15.3.2.6 Patient Survey Data

The patient survey data consistently captured additional information about patient characteristics, such as diabetes self-monitoring measures and levels of patient activation. These measures were analyzed in SPSS to produce descriptive data about the patients surveyed at each site (for example, mean, standard deviation, and median) in order to understand participant differences across the various clinic sites. Quantitative analysis beyond simple descriptive statistics was not performed because of the small number of patients surveyed and the primary qualitative approach.

15.3.2.7 Data Synthesis

Data synthesis compared and contrasted all health IT and workflow-related data gathered across six sites during two or three (depending on the site) observation periods over 12 months. As detailed earlier, data collection spanned clinic groups in different phases of MHTAV program implementation (already using MHTAV or in the process of adopting MHTAV). Findings gathered from multiple sources with qualitative and quantitative methods were therefore used to examine the strength of support for the identified themes, conflicts in the findings, and the development of final conclusions. Table 15.4 describes the research products that address the research question. Three categories of research products were identified and described: (1) workflows, (2) health IT design elements, and (3) interactions between the workflows and health IT elements.

Table 15.4 Description of research product(s) for each analysis activity

Analysis activity	Source of data	Product
A. Workflow diagramming to identify and describe workflows	Semi-structured staff discussion Direct observations Staff interviews Patient interviews	Set of workflows and workflow elements
B. Identification of health IT design elements used in support of care coordination activities	Semi-structured staff discussion Direct observations Staff interviews Patient interviews Staff surveys Usage data Diabetes outcome data	Set of health IT design elements
C. Identification of interactions between workflow and health IT design elements	Analysis activities A and B Underlying source data	Set of interactions, health IT barriers and facilitators to care coordination workflows
D. Analysis of interactions across implementation stage (MHTAV, MHTAV-adopting) and time	Analysis activities A, B, and C Underlying data	Interaction results by implementation stage

15.3.2.8 Interactions Between Health IT and Workflow

The data analyses described above would help us derive a "technology matrix" to capture clinical workflows that comprise care coordination; and the health IT features or components that either support, create barriers for, or have a neutral impact on the workflows. "Good alignment" describes a positive interaction between health IT and workflow. "Neutral alignment" is neither positive nor negative. "Poor alignment" describes a negative interaction. The overall "fit" of a health IT feature in supporting or impeding workflow can be then assessed by looking at the alignment of the feature with individual workflows of a work activity.

15.3.3 Findings

15.3.3.1 Health IT Impact on Workflow in Key Work Domains

Our study identified seven domains of activity central to the work of care coordination, and around which the study results are organized. Five of these activity areas addressed the primary work of the CCs:

1. Establishing and maintaining relationships with patients
2. Establishing and maintaining a POC
3. Collecting and analyzing home monitoring data
4. Educating and coaching patients
5. Coordinating with other clinicians and patients

The remaining two *supported* the primary work of CCs:

6. Searching for information to support decision making and action
7. Prioritizing tasks and planning work

In this section, we present the findings from two of these seven work domains, namely "establishing and maintaining relationships with patients" and "coordinating with other clinicians and patients." For each of them, we include a *description,* a *workflow diagram* of activities observed and/or discussed in interviews, a *technology matrix* that depicts the level of alignment of health IT features with the workflow, and a summary of findings. We chose to provide a detailed report on only two domains in order to fully explain the methodology we used to analyze and depict the data. We direct readers interested in the additional findings to the final report of the study published by the AHRQ, accessible at https://healthit.ahrq.gov/sites/default/files/docs/citation/hit-enabled-care-coordination-and-redesign-in-tn-final-report.pdf.

15.3.3.2 Establishing and Maintaining Relationships with Patients

Initial engagement of the patient in the care coordination program. As the MHTAV program was initiated in each clinic, potential patients were displayed on the MHT system worklist, based on dynamic registries using existing EHR data, behind the scenes. The registries used a risk stratification schema that represented two dimensions: (a) disease control and stability (for diabetes patients, "level 1" criteria were: documented HbA1c less than 8, fewer than 3 medications for diabetes, no complications OR mild stable complications AND followed by a subspecialist, without severe or frequent hypoglycemia or hypoglycemic unawareness); and (b) complexity of primary disease and related comorbid conditions. Initially, the registries were used to populate a worklist of patients that CCs needed to enroll manually into the program, with a face-to-face meeting in the next provider visit. Later, to accelerate enrollment, the decision was made to move to an auto-enrollment model, whereby patients whose records were identified by the registry were automatically enrolled into the MHTAV program and placed on the CC worklist. With this change, face-to-face meetings in the clinic became uncommon, as CCs moved to telephone-based outreach to meet and set up the POC for each patient.

In the early phases of the program, a clinician initiated the patient enrollment meeting with the CC, which typically took place face-to-face in the clinic during a scheduled clinic visit. One CC noted that 10–11 patients per day were enrolled at first; then after the first few months the number dropped substantially to approximately 7 per week since the majority of eligible patients were already enrolled. At a later point in the MHTAV program, an auto-enrollment process was implemented through which patients who met certain clinical thresholds (for example, HbA1c > 8) automatically became part of the MHTAV program population. CCs were then expected to create a POC for each patient who was auto-enrolled, even without a face-to-face meeting. A CC who described this process pointed out the impact on establishing and maintaining the relationship with the patient: "I can see that it's made a difference. I feel like they, you know… you build that rapport so they trust you and they, they try to… do what you're asking them to do and you know I have a lot of them, [who] take their readings and do, and keep, record that stuff regularly."

Ongoing engagement. The CCs reported that engaging the patients in an ongoing way over time was an important aspect of their work. Developing and maintaining strong relationships with patients helped with obtaining home readings (blood pressure and blood glucose), following up on medication effects, identifying hospital admissions, and monitoring other clinical events. Fostering a friendly and collegial relationship was especially important because CCs could learn about patients' jobs and families, explore with patients what made adherence to clinical recommendations difficult, and share experiences with patients (such as a shared joke), all of which helped establish rapport and trust. For example, one CC could not reach one of her patients for approximately 1 year, but once the patient met with the CC face-to-face during a clinic visit, she began communicating with the CC regularly about her medical care. Another CC described how the care team was able to keep a patient out of the hospital through education, medication, and diet management. She mentioned the face-to-face communication as key during this process, as both the CC and the patient were able to see and discuss the positive changes as they occurred.

Care coordinators maintained contact with patients through calling on the telephone, messaging through the patient portal, and meeting face-to-face in the clinic. CCs used the clinic schedule to determine if one of the patients they were following would be visiting that day.

However, advances in technology did not always support maintaining patient relationships. For example, when auto-enrollment replaced the need for a face-to-face enrollment meeting with the patient, the CCs felt that their ability to initially engage the patient, and maintain strong engagement, suffered. They stated that the ability to see patients face to face on a regular basis is helpful for maintaining engagement. One CC suggested that Skype or FaceTime may be an alternative strategy for communicating with patients. CCs also noted variation in communication preferences based on a patient's age. They commented there appears to be a cohort of patients (aged approximately 40–50) who prefer to use the messaging function through My Health at Vanderbilt rather than the telephone. The CCs speculated that these patients are employed full time and have more constraints on their time, making online communications easier to accomplish.

Relationship-building activities. The CCs used several strategies to build relationships with patients. These strategies included setting reminders to see patients while they were in the clinic; making notes in the POC Support tab for future reference (memory cues); and providing educational materials to patients. CCs mentioned that having patients visit with them in-person in the clinic helped to create and maintain rapport. For patients who were difficult to engage, CCs described introducing themselves again when the patient came in for an appointment, offering them information and log sheets, and any other assistance to try to reconnect with them.

During our observations, CCs mentioned that reduced in-person contact with patients, either because CCs visited multiple clinics or because their office was outside the clinic building, changed the nature and strength of their relationships with patients. As mentioned previously, CCs also felt that auto-enrollment may be a barrier to establishing strong relationships with each patient.

Figure 15.3 and Table 15.5 present the workflow diagram and technology matrix for establishing and maintaining relationships with patients. Figure 15.3 illustrates

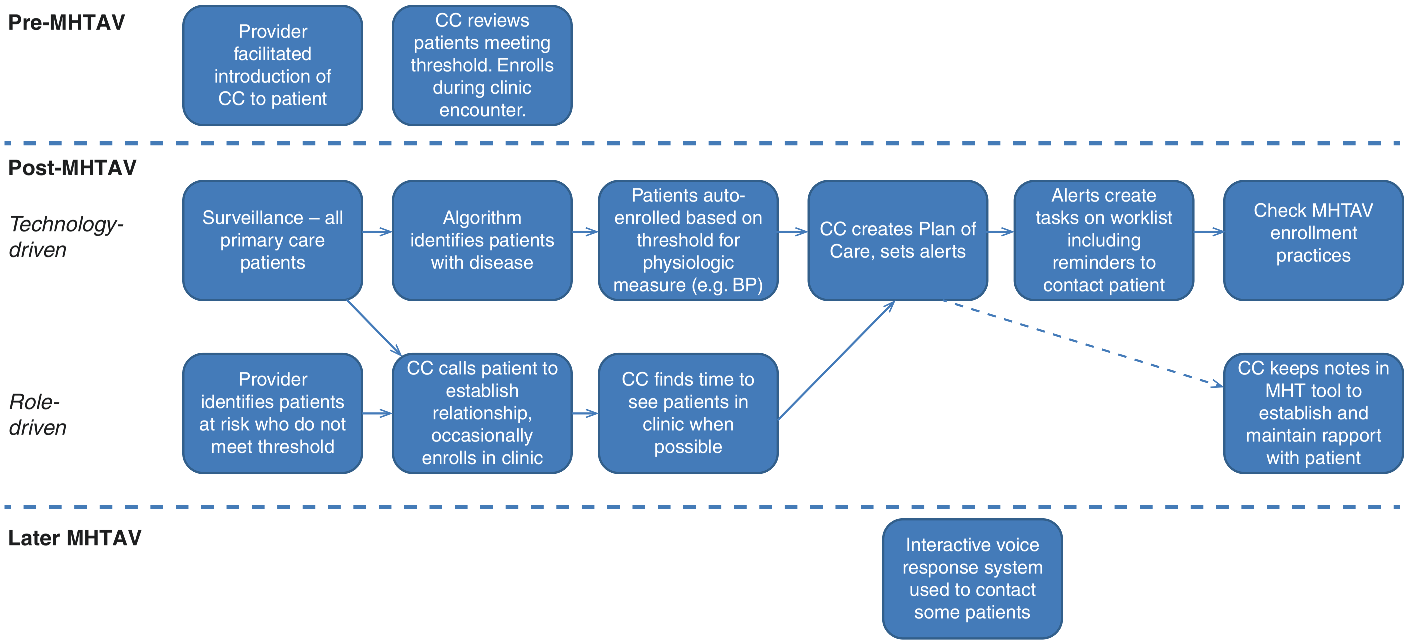

Fig. 15.3 Workflow diagram: establishing and maintaining relationships with patients. *CC* care coordinator, *BP* blood pressure, *MHT* My Health Team, *MHTAV* My Health Team At Vanderbilt

Table 15.5 Technology matrix: establishing and maintaining relationships with patients

Relevant IT resources or attributes	Workflow: establishing and maintaining relationships with patients	
	Activity: enrollment/auto-enrollment	Activity: building rapport with patients
Alerts and reminders populate the CC worklist	Reminders are used to connect with patients during clinic appointments. This can assist in educational goals, as well as supporting the patient by providing monitoring equipment, validation of monitoring equipment. ***Good alignment***	Reminders to call/message patients or connect with them in clinic. Opportunity for CC to build rapport via face-to-face communication. ***Good alignment***
Disease Control Form (DCF)	Displays information about patient, including the next appointment. ***Good alignment***	DCF shows status of patient and allows CC to update status based on information received from communications with patient. ***Good alignment***
POC Support tab	Records activities involving initial patient contact, and assists in establishing the POC for the patient. ***Good alignment***	Enables ongoing communication with patient, as well as input of possible pertinent information about the patient home environment ("Red Flags": Activity, Diet, Foot care, Emotion coping skills, Disease monitoring, Unable to reach patient, Physical activity, Medication adherence, Medication reconciliation, Tobacco cessation, and Other categories). ***Good alignment***
POC Support tab (continued)		"CC Actions" are entered here, and a history is maintained in the "POC Support Hx." CC Actions contain information about education/coaching given to patient, and also monitoring equipment status (that is, validation of existing equipment or providing one to patient). These serve as memory cues to establish and build rapport with patients. ***Good alignment***
Auto-enrollment process was implemented in later stages of MHTAV	Patients enrolled without meeting the CC in the clinic, minimizing CC work. ***Good alignment***	CCs reported face-to-face meetings with patients were important to rapport-building. ***Poor alignment***

CC care coordinator, *DCF* disease control form, *POC* plan of care, *Hx* history, *MHTAV* My Health Team at Vanderbilt the change over time that occurred before, during MHTAV, and later in data collection. As technology was introduced to identify, enroll, and later, contact the patients, direct CC initial contact with many of the patients decreased.

The middle section of the diagram in Fig. 15.3 illustrates the two ways in which relationships are established and maintained within the MHTAV program. Technology-driven refers to the MHT system itself, including algorithms used to trigger alerts and set the status of patients in the MHTAV program. Role-driven refers to ways in which CCs engage patients and establish relationships on a more personal level. Before MHT tools were introduced, CCs were introduced to patients by a provider or clinical team member. This continued, though reduced, after the MHT tools were introduced.

15.3.3.3 Coordinating with Other Clinicians and Patients

As the MHTAV program was implemented, it took time for the clinic teams to embrace the CCs as key members. Initially, a team member sometimes inadvertently duplicated the effort of another team member (for example, LPNs sent messages to the provider and/or patient not realizing the CC also called and/or sent messages about the same topic). Over time, other team members (providers and clinic nurses) learned about the CCs' capabilities and role and learned how the CCs could significantly contribute and efficiently function on the team. However, CCs who were off-site or part-time with the clinical team lacked daily contact with providers, who were in turn less aware of the various tasks and activities that CCs performed. Some CCs reported having to actively promote their abilities, such as assisting with patient education, reviewing home measurement techniques, and spending time responding to patient questions, especially those who relied on electronic communications and telephones to reach physicians/NPs and clinic nurses they did not interact with face-to-face.

The care team often wanted the CC to meet with patients immediately before or after a patient saw his/her provider at a visit, requiring communication. This was challenging when a patient was newly identified for inclusion in MHT, for example in the cases of new patients whose diabetes was not known by the clinic until the initial visit, new laboratory results that indicate diabetic status shortly before or during the visit, a patient who shows low adherence and the need for further education, or cases in which a patient requests more information or education regarding the self-management of their chronic illness. However, it was not easy for the CC to figure out which patient needed to be seen, to know when a patient was actually done seeing a provider, or to receive a provider message that they should see the patient, despite multiple communication technologies. The EHR message basket (or email) could be helpful if the CC was at her computer; the online schedule helped the CC prepare for the patients visiting each day; and the online whiteboard assisted the CC in knowing when a patient arrived and checked in. However, messages were not always used to notify the CC, up-to-date information was often missing from the schedule, and the whiteboard often lacked accurate information about when the patient was actually being seen by a provider, making it difficult for CCs and providers to coordinate a face-to-face meeting for the patient with the CC. As a result, CCs often learned later that they needed to schedule a separate appointment to meet with the patient.

MHT worklist alerts, whether system triggered or created by the CC, provided valuable information to the CC in monitoring and acting on "to do's" for each patient. There were a lot of activities to manage, such as requesting and following up on laboratory tests, checking on the patient experience using a new or changed medication, and following up on teaching. CCs reported good alignment between these tools and their work coordinating future activities for patients.

Coordination activities were also observed to vary among teams from urban, suburban, and rural areas. The rural clinic CC interacted with a variety of non-Vanderbilt affiliated hospitals and clinicians, frequently exchanging information via fax. In contrast, CCs in the suburban and urban clinics more often only interacted with Vanderbilt-affiliated hospitals and providers, reflecting real variation in the information ecologies within which the teams worked.[22]

Figure 15.4 and Table 15.6 present the workflow diagram and technology matrix for coordinating with other clinicians and patients.

15.4 Discussion

15.4.1 Lessons and Insights

The rigorous, mixed methods study of six site teams at various stages of adoption of health IT to support new care coordination team-based care generated a large amount of data and was itself a complex undertaking. To assess the interaction between technology and the work system for care coordination, with its multiple workflows, actors, tasks, and multidirectional influences between technology and workflow, we identified and examined seven broad areas of work. Those seven areas included the routine use of technologies by the care coordinator, clinical teams, and patients. Many more use cases were partially addressed or not addressed in this research study, in part due to time and budget limitations. The research team observed that many other factors such as cultural, physical, policy, and social environments played an important role in the health IT–workflow interactions we observed, making it important to situate our specific questions about health IT and workflow within a broader context.

15.4.2 Health IT Design

Our main finding, that the overall impact of health IT on workflow was mixed, was not surprising. It made sense that multiple work activities, roles, and technologies interacting in the real-world environment of primary care practices

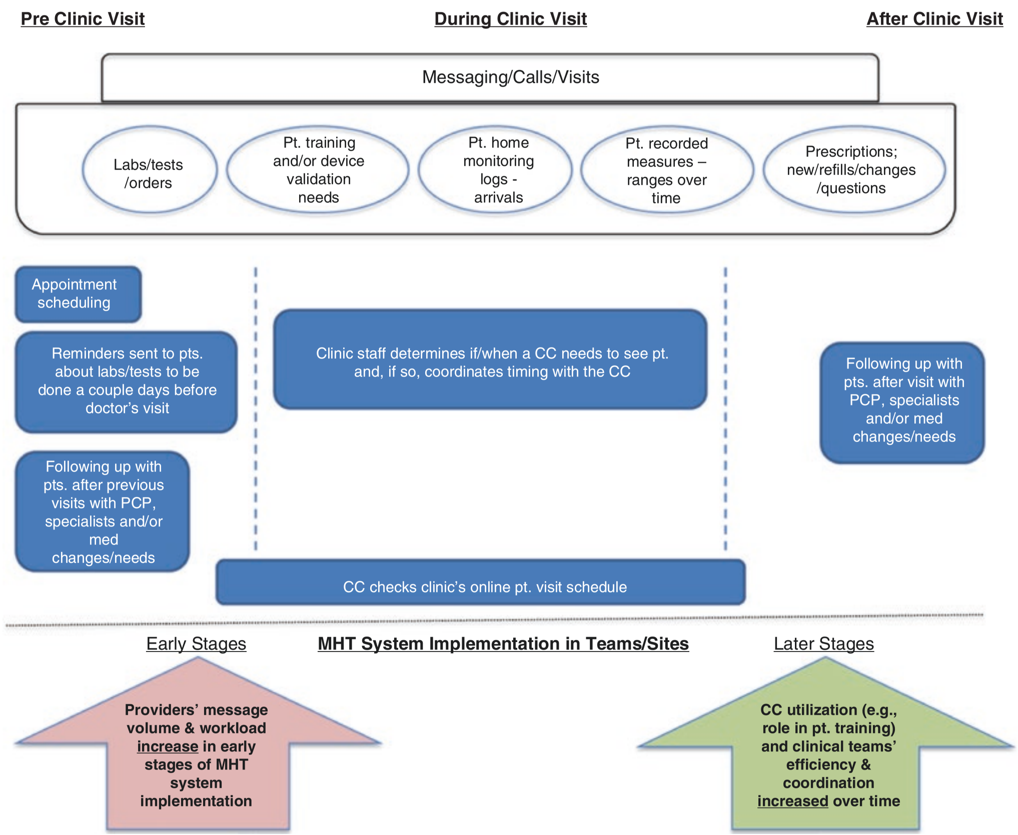

Fig. 15.4 Workflow diagram: coordinating with other clinicians and patients

Table 15.6 Technology matrix: coordinating with other clinicians and patients

Relevant IT resources or attributes	Workflow: coordinating with other clinicians (nurses & PCPs)		
	Activity: messaging	Activity: medication changes and refills	Activity: prompts to CCs and patients
MHT worklist alerts and reminders		Notify CCs (or IVR system) to follow-up with patients about new or changed medications on a certain date. ***Good alignment***	Reminders are used to notify patients to come in for a lab/test a few days before their doctor's appointment *Good alignment* Alerts and reminders notify CCs when a patient's status (readmitted to hospital) has changed, a medical appointment has or will soon occur, and/or CCs need to follow up with the patient to see how they are doing and/or how an appointment went. ***Good alignment***
Electronic communications: In-basket/MHTAV messages	Convenient method for CCs to notify clinicians when they need to act (such as to review a patient's BP or blood glucose data, or that a patient needs training or a monitoring device validated). ***Good alignment*** Clinicians having a large number of messages sent by the CCs can feel overwhelmed and wish the technology helped to alleviate this. ***Poor alignment***	Prescription requests and/or information and questions about medications can be e-mailed among CCs and the clinicians. ***Good alignment***	Electronic messaging (MHAV and/or e-mail) has helped CCs when scheduling appointments with patients. ***Good alignment***
	Messages sent/received to coordinate the best time for the CC to see the patient are often not received in time. ***Poor alignment***		

Table 15.6 (continued)

Relevant IT resources or attributes	Workflow: coordinating with other clinicians (nurses & PCPs) Activity: messaging	Activity: medication changes and refills	Activity: prompts to CCs and patients
Clinic schedule for viewing by CCs			The online schedule is unreliable due to delays, early arrivals, cancellations, and/or no-shows. CCs often must schedule another appointment to see the Pt at a different time. ***Poor alignment***
Interactive voice response (IVR) system asks patients, about new or changed medications (if patient has consented)		IVR system only asks generic and broad questions that often lack specific and contextual information. ***Poor alignment***	Since the IVR system is not always reliable, the CC doesn't get sufficient or reliable information and must call the Pt to ask about their new/changed med. ***Poor alignment***
CCs schedule or availability status is not accessible remotely/ electronically			Clinic staff are unable to easily and quickly coordinate a face-to-face encounter between a patient and the CC. Instead, staff go to the CC's office or call her, if they have time. ***Poor alignment***

BP blood pressure; *CC* care coordinator, *HR* heart rate, *IVR* interactive voice response, *MHTAV* MyHealthTeamAtVanderbilt, *MHT* My Health Team, *Pt* patient

would surface many examples in which workflow was supported by, as well as at odds with, health IT.

The observed differences in alignment of health IT and workflow at different practice sites, and over time, were a strong reminder that technology redesign and practice redesign are both ongoing. Whether technology changes are secondary, made in response to other changes such as new staffing roles, new workflows, or patient direct use of technology, or primary, such as a new dashboard for monitoring population health, our findings suggest that plan-do-study-act (PDSA) steps to observe the actual effects of changes in health IT on workflow are important. Redesign work is best performed by a team of individuals combining their expertise in health IT, workflow, and clinical care. It is not unusual for redesign work to progress through a series of iterations to introduce new features and test their impact. This is especially useful when adapting complex systems where changes in multiple areas are common.

15.5 Conclusion

In this mixed methods study assessing the workflow impact of implementing health IT-enabled care coordination in six ambulatory primary care clinics over a 12-month period, we used a human factors and sociotechnical framework that identified five areas of primary work and two areas of supporting work. This approach revealed a complex picture with multiple workflows and varied IT systems used alone and in combination to support those workflows.

Our findings support the WEM assertion that context, aggregation, and temporality can impact the alignment of health IT and workflow. Stronger satisfaction with care coordination tools and processes was noted when there were well-defined workflows, tools designed to fit the workflow, adequate training, good team communication, physical co-location of CCs with other care team members, stronger team relationships, and time to allow the new work system to stabilize and for learning to take place. This study shows that the work of care coordination is broad, complex, and varied. It also demonstrates that even when a specific health IT-enabled program is implemented in a consistent IT environment, its impact varies substantially depending on the physical, social, and policy environment. Alignment between health IT and workflow is dynamic rather than fixed because the implementation of care coordination is changing over time from a narrow scope (a primary focus on the introduction of the new CC role and a few conditions) to a much broader one (a greater focus on team-level communication, multiple contributing roles, and more conditions).

Through the study, we also explored the use of the health IT alignment matrix as a tool to communicate to what extent system components aligned with functional and workflow requirements, and "scoring" of the overall alignment for a work system. Future work is needed to improve the way multiple contributors are identified and tracked during health IT adoption and its redesign over time.

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