FINAL CONTRACT REPORT

Using Health IT in Practice Redesign: Impact of Health IT on Workflow

Health IT-Enabled Care Coordination and Redesign in Tennessee

AHRQ
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HEALTH IT

Final Contract Report

Health IT-Enabled Care Coordination and Redesign in Tennessee

Prepared for:
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
540 Gaither Road
Rockville, MD 20850
www.ahrq.gov

Contract No. HHSA 290-2010-00024I

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AHRQ Publication No. 15-0048-EF
June 2015

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Suggested Citation:
Wald JS, Novak LL, Simpson CL, et al. Health IT-Enabled Care Coordination and Redesign in Tennessee. (Prepared by RTI International, under Contract No. 290-2010-00024I). AHRQ Publication No. 15-0048-EF. Rockville, MD: Agency for Healthcare Research and Quality. June 2015.

None of the investigators has any affiliations or financial involvement that conflicts with the material presented in this report.

This project was funded by the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The opinions expressed in this report are those of the authors and do not reflect the official position of AHRQ or the Department of Health and Human Services.

Acknowledgments

We would like to thank Josh Peterson, Richard Holden, Kim Unertl, Bill Gregg, and Shilo Anders, who contributed to the design of the study. We would also like to thank all of the study participants for the contribution of their time and insight.

Preface

This project was one of three task order contracts awarded under the request for task order (RFTO) titled "Using Health IT in Practice Redesign: Impact of Health IT on Workflow." The RFTO funded methodologically rigorous research studies of the implementation of health IT in support of practice redesign in ambulatory care settings. These studies were designed to provide an enhanced understanding of the causal relationships between health IT and workflow processes.

About ACTION II

This project was funded as an Accelerating Change and Transformation in Organizations and Networks (ACTION) II task order contract. ACTION II is a model of field-based research designed to promote innovation in health care delivery by accelerating the diffusion of research into practice. The ACTION II network includes 17 large partnerships and more than 350 collaborating organizations that provide health care to an estimated 50 percent of the U.S. population.

For more information about this initiative, go to http://www.ahrq.gov/research/findings/factsheets/translating/action2/index.html

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List of Terms

Abbreviation	Full Term	Definition/Description
AHRQ	Agency for Healthcare Research and Quality	Federal Agency within the U.S. Department of Health and Human Services. Its mission is to produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable, and to work within the U.S. Department of Health and Human Services and with other partners to make sure that the evidence is understood and used.
BP	Blood Pressure	Patient measurement; has systolic and diastolic components
CC	Care Coordinator	New role introduced as part of the MHTAV program. CCs are registered nurses who help coordinate care for patients with one of three chronic conditions
DCF	Disease Control Forms	Tool used by the CC to request that a provider review new information and make a decision
EHR	Electronic Health Record	Digital version of a patient's paper medical record
IT	Information technology	In this report, IT specific to the MHTAV program is called "MHTAV" tools or "MHT" tools or "MHT" system; IT used to deliver care is called "Health IT;" any other IT is called "General IT"
IVR	Interactive Voice Response	Remote data collection system with a telephone interface configured to contact patients and ask medication-related questions or ask for information about blood pressure or blood glucose
LPN	Licensed practical nurse	LPNs served as clinic nurses along with RNs.
MA	Medical Assistant	Clinical staff who room the patient, obtain vital signs, and assist the provider
MHAV	My Health at Vanderbilt	Secure patient portal used at VUMC for secure messaging and sharing of clinical information with the patient
MHT system (or tools)	My Health Team system (or tools)	Software developed to support care coordination activities. Includes dashboards (for one or more disease condition); worklists; the plan of care, the disease control form; alerts and reminders; the journaling tab from MHAV; and the IVR system.
PAM	Patient Activation Measure	Survey administered to patients to assess knowledge, skills, and confidence to manage their health
POC	Plan of Care	Electronic document and monitoring system for condition-specific care information
RN	Registered nurse	RNs served as clinic nurses along with LPNs. CCs were also licensed as RNs but serve in a different role than clinic nurses, so they are referred to by their CC role in this report
SDSCA	Summary of Diabetes Self-Care Activities	Survey administered to patients about their health behaviors related to diabetes
SPSS	SPSS	Statistical software
StarPanel	StarPanel	Electronic health record (EHR) system used at Vanderbilt
TAM Survey	Technology Acceptance Model Survey	Survey administered to clinicians and care coordinators to assess their perceptions and acceptance of technology
VUMC	Vanderbilt University Medical Center	Affiliation of the six study practices

Executive Summary

Background

The need for effective health information technology (IT) to manage electronic patient data and to support redesigned systems of ambulatory care has expanded as the number of providers using electronic health record (EHR) systems has grown. Yet health IT and the work systems it supports are not always compatible. Health IT-workflow interactions, best understood through a human factors and sociotechnical framework, have not been extensively or rigorously studied, and published research is not always informative to organizations seeking to use health IT systems to support redesign of their ambulatory care settings. This qualitative study of care coordination and health IT-enabled redesign used rigorous qualitative methods to assess the alignment between health IT and workflow during the implementation of a comprehensive care coordination program in ambulatory care settings.

Research Question

The central research question for this study was: What is the workflow impact of implementing health IT-enabled care coordination within six ambulatory primary care clinics?

Methods

A formal mixed-methods approach employed direct observation, patient and staff interviews and surveys, artifact and spatial data collection, and software use monitoring to study six site teams at Vanderbilt University Medical Center (VUMC)-affiliated primary care clinics that were in different phases of introducing My Health Team At Vanderbilt (MHTAV). MHTAV is a care coordination program that included a new care coordinator (CC) role and new health IT components called the MHT tools. In addition to using the existing Vanderbilt EHR system (StarPanel), patient portal (My Health At Vanderbilt [MHAV]), online patient education materials, messaging, online whiteboard , and the clinic scheduling system, the MHTAV program added: (1) diabetes, hypertension, and congestive heart failure dashboards, (2) worklists used by CCs, (3) a Plan of Care (POC) for the patient, (4) a disease control form (DCF), (5) CC alerts and reminders, (6) a patient portal journal for sharing home monitoring information, and (7) an interactive voice response (IVR) system.

Iterative observations and supplemental data collected over 12 months for each site team were used to explore health IT-workflow interactions over time in three clinics that already implemented MHTAV (MHTAV sites) and three clinics that were newly introducing MHTAV (MHTAV-adopting sites). Qualitative data were analyzed using open coding, axial coding, and workflow modeling steps based on the SEIPS (Systems Engineering Initiative for Patient Safety) and WEM (Workflow Elements Model) frameworks. Workflow diagrams and technology matrices were used to summarize the interactions between tools and workflows, with good alignment (positive impact), neutral alignment (neither positive nor negative impact), or poor alignment (negative impact) shown in specific cells of an interaction matrix. Quantitative data were tabulated using simple descriptive statistics. The main focus of this analysis was to understand the impact of health IT components used by CCs and their care teams to perform the new care coordination work activities.

Results

Data from 24 staff interviews and surveys, 40 on-site team observations, 57 patient interviews and surveys, and 14 months of utilization data formed the qualitative dataset and quantitative supplemental data used in the analysis for this project. Since the new CC role and MHT tools served as the centerpiece of the MHTAV program, this analysis viewed the role of the care coordinator as a primary focus, and considered providers and other team member work in relation to the work of the CC.

The overall impact of health IT on care coordination workflow was mixed, varying from good to neutral to poor, depending on the specific task, technology, user, and use of health IT. Impact could not be assessed as a one-dimensional measure (good or bad, high or low) because it varied by role, over time, and in different clinical settings and contexts, as shown in the workflow diagrams and technology matrices.

Five primary areas of care coordination work and two areas of supporting work were identified from analysis of interview and observation field notes. The primary work of the CCs was: establishing and maintaining relationships with patients (activity 1) and a POC (activity 2), collecting and analyzing home monitoring data (activity 3), educating and coaching patients (activity 4), and coordinating with other clinical staff and patients (activity 5). Two additional activity areas supported the primary work of the CCs: searching for information to support decisionmaking and action (activity 6), and prioritizing tasks and planning work (activity 7).

CC work in these seven areas was enabled by multiple forms of IT, including new health IT (MHT tools), existing health IT (the EHR, patient portal, online patient education materials, messaging, and online whiteboard), and general IT (scheduling system). The workflows for each care coordination work area were modeled using a workflow diagram. The interaction between each IT component (whether MHT tools, health IT, or general IT) on CC work was summarized in a technology matrix for each primary work area using the concept of fit (or alignment) between the technology and the workflow as good, neutral, or poor.

The IT impact on workflow was mixed overall. Alignment was impacted by a variety of software, workflow, and contextual factors. CC work in each area was enabled by multiple components of health IT used together. The interaction matrix helped us to focus on each IT component of CC work individually and to consider context. Context was best uncovered through observation and interviews. For example, the use and impact of certain kinds of IT on care coordination work differed when CCs were physically co-located with the care team instead of on a different floor or building. The usefulness of the EHR for seeking patient information was mixed because some information was easy to find and use (good alignment), while other information such as documents from other source systems that were scanned into the EHR were illegible and difficult to use (poor alignment). Another example of mixed alignment concerns the introduction of new IT support of patient enrollment in the MHTAV program. Earlier in the implementation of the program, CCs contacted patients by phone, which took time but helped establish a relationship between the CC and the patient; later in the implementation patients were automatically enrolled in MHTAV based on clinical thresholds (for example, hemoglobin A1c>8), without a phone call from the CC, saving time but weakening the level of direct engagement between the CC and patient at the start.

These and other examples showed that even when health IT specifically enables workflow, in a wider context its impact is more nuanced, suggesting the importance of a broad sociotechnical approach to developing and implementing programs such as this one. The SEIPS and WEM

frameworks predicted that interactions between different elements in the framework would mediate the impact of health IT on workflow, and they did.

Discussion and Conclusion

Multiple work activities, roles, and technologies interacted in this real-world environment of six primary care practices introducing (or having introduced) care coordination redesign. With many different IT components functioning individually and together to enable and support various workflows, the overall impact of health IT on workflow was mixed. The impact was best understood by examining seven broad areas of work and a variety of technologies in routine use by the care coordinator, clinical teams, and patients.

Cultural, physical, policy, and social environments were observed to play an important role in many of the health IT – workflow interactions we observed, and factors in one part of the work system often affected other parts. A rich understanding of the impact of health IT on workflow emerged. For example, while the POC tool had a strong positive impact on CC work, it also lacked space for documenting reasons for plan modifications in some cases. Also, the impact of the POC was reduced because of limited use by providers and nurses caring for the same patients as the CC, which also may have reduced their awareness of the CC's role.

The impact of health IT features on communications was also mixed. The convenience of secure messages for clinical communication about patients (via the EHR) and with patients (via the patient portal) was clear, but not always useful in the context of trying to connect a CC with a patient during a visit. Another example of mixed impact was using health IT to search for information in the medical record, which was hit or miss depending on the specific kinds of information, how it was stored, and the approach used to try to locate it.

Opportunities to increase the positive impact of health IT on workflow were identified. One concerned the overall adoption of the MHTAV program itself. If MHT tools were aimed at all care team members, rather than just the CC, there would likely be a positive impact on how well the CC role was understood, improving transparency, and avoiding duplicate work. In many cases the impact improved somewhat over time as CCs adapted their work to the available technology, as individual and group learning occurred, as care coordination routines solidified, and as expectations to fully integrate the CC role strengthened along with team culture. In some cases the impact decreased over time, such as when policy changes and new uses of IVR technology reduced direct contact between CCs and patients, initially.

Care coordination activities in ambulatory settings, especially primary care, can benefit substantially from the effective use of health IT. 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 fairly uniform IT environment, its impact can vary substantially with differences in the physical, social, and policy environment, and as the implementation of care coordination shifts from a narrow scope (the new CC role, and one chronic condition) to a broader one (multiple chronic conditions). This report highlighted a number of opportunities to improve the impact of health IT on care coordination activities through the work of technology designers, program leadership, and those who perform the daily activities of care coordination.

Section 1. Background and Purpose

Background

Gaps in Prior Research on Workflow

The need for effective health information technology (IT) to manage electronic patient data and to support redesigned systems of ambulatory care is expanding as the number of providers and hospitals using electronic health record (EHR) systems grows. However, anticipated benefits of health IT are difficult to achieve unless implementation and workflow challenges are identified and addressed.[1-5] Health IT-workflow interactions are best understood through a human factors and sociotechnical framework,[6] but large gaps in systematic research of ambulatory care workflow still exist.[7]

An AHRQ-funded study of existing research and evidence about the impact of health IT on workflow, its linkage to clinician adoption, and its links to the safety, quality, efficiency, and effectiveness of care delivery, found evidence of variable quality. Most of the articles were not focused directly on workflow, and most described research completed in large clinics affiliated with academic medical centers, health maintenance organizations, or national health systems outside the United States, limiting applicability to other settings, particularly small and medium-sized primary care and other ambulatory care settings. Also, most of the studies did not use a scientifically rigorous design. Finally, most of the literature did not include descriptions of the sociotechnical context of health IT implementations and use, making it difficult to understand the role of potentially conflating or mediating factors such as training, technical support, and organizational culture.

These gaps and limitations of existing research, study designs, and findings related to health IT and workflow limit the relevance and quality of the available evidence for health care organizations wishing to implement health IT systems to support current workflow processes. The existing evidence is of equally limited use to those organizations seeking to use health IT systems to support redesign of their ambulatory care settings.

Carayon's[7] work also identified significant gaps in understanding health IT-workflow interactions based on extensive literature review, and advises that more systematic research is needed. However, establishing causal relationships and highly generalizable knowledge in the study of health IT workflow interactions can be challenging. Although randomized controlled trials (RCTs) are strong designs for establishing a causal link between health IT interventions and "hard" clinical outcomes, they do not always uncover more "proximal" effects of health IT on work systems. In contrast, case reports and ethnographic studies, while useful for understanding workflow, are often inconclusive regarding cause and effect or cannot be generalized.

This study was designed to address two major gaps in the literature.[7]

- **Rigorous research focused on workflow**. Unlike most previous studies, this study uses a combination of methods specifically designed to understand workflow in the context of a work system implementing new health IT. The methods have been refined over decades of research on workflow.[8] These adapted methods were implemented by experts in sociotechnical systems research in partnership with clinical subject matter experts. By focusing directly on workflow, this study provides 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 was designed to understand 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 purposely focus 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 permits this study to both describe this context and allow comparisons to other contexts. It also permits the research team to understand what specific contextual factors influence workflow-related phenomena—for example, under what circumstances does implementing the same health IT system lead to divergent workflow changes and why?

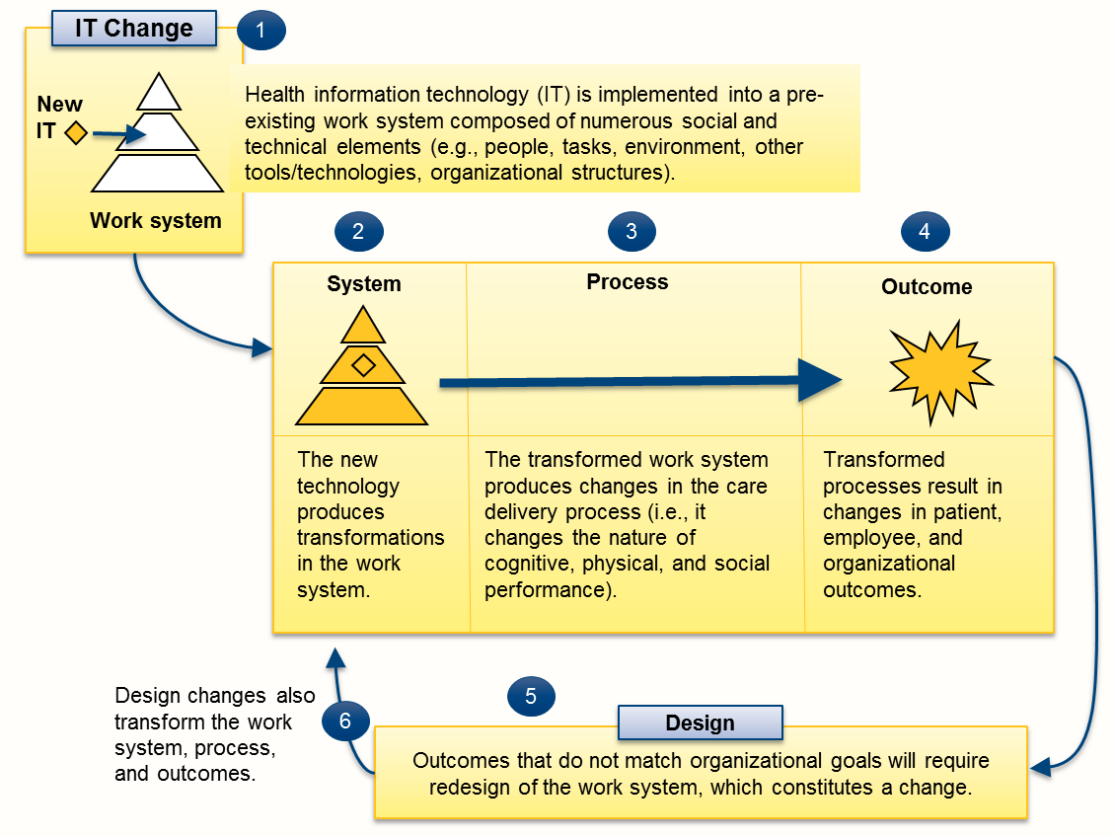
This approach aims to improve on prior health IT-workflow investigations on the basis of the following:

- Use of an established theoretical framework.
- Systematic, detailed observations by experienced staff.
- Multiple data-gathering methods including staff and patient perspectives.
- Changes observed over time; workflow analysis comparisons at different points in practice redesign.
- A research team experienced in the theory and practice of studying workflow, implementation challenges, human factors, health IT in chronic disease care, and diabetes care coordination.

Theoretical Framework

The study's theoretical framework combines two compatible models that have been applied to workflow research: the adapted SEIPS (Systems Engineering Initiative for Patient Safety) model[9-11] and the Workflow Elements Model (WEM),[8, 12] depicted in Figures 1 and 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 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 Figure 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.

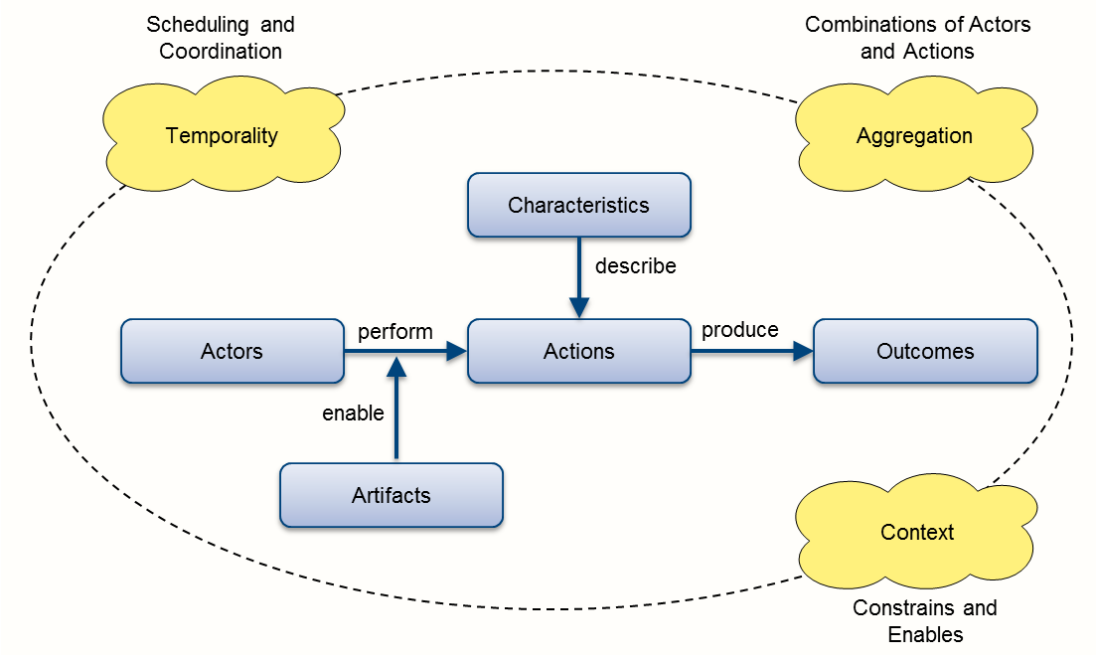
Figure 1. The Adapted SEIPS Model



Source: Holden et al.[13]

Note: This graphic is reprinted under a Creative Commons license.

Figure 2. Workflow Elements Model



Source: Unertl et al.[12] Note: This graphic is used with author's permission.

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.[8] 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.[10]

The two models in combination guided data collection 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.

Care Coordination and My Health Team at Vanderbilt

The goal of this project was to understand the impact of implementing health IT-enabled care coordination on workflow in primary care clinics in various stages of practice redesign. Care coordination is defined 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."*[14]

The My Health Team at Vanderbilt (MHTAV) program was initially developed in 2010 by 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 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 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 includes intensified patient engagement and dedicated care coordinators (CCs). As part of care coordination redesign, major IT system components were developed or used in support of care coordination activities, including: (1) the Vanderbilt 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 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. Table 1 summarizes the IT components in the clinical care environment. Users are shown in the order of frequency of use.

Table 1. Information Technology Components Relevant to the MHTAV Program

IT Category	Component	Users
New Health IT: MHT system (or MHT tools)	Diabetes, hypertension, and congestive heart failure dashboards	CC, MA
	Worklists	CC
	Plan of Care (POC)	CC, MA, MD, NP
	Disease Control Form (DCF)	CC, MD, NP
	Alerts and reminders	CC, MA
	Journaling tab from MHAV	CC, MA
	Interactive voice response (IVR) system	CC, MA, patients
Health IT	Vanderbilt EHR (StarPanel)	MD, NP, clinic nurses, MA, CC
	Patient portal secure messaging (My Health at Vanderbilt)	MD, NP, clinic nurses, CC, MA, patients
	Online patient education materials	CC, MA, patients
	Message basket*	MD, NP, clinic nurses, CC, MA
	Online Whiteboard	MD, NP, clinic nurses, CC, MA
General IT	Clinic scheduling system	PSR

IT = information technology; MD = physician; NP = nurse practitioner; MA = medical assistant; CC = care coordinator; PSR = patient services representative; POC = plan of care. *Message basket is part of StarPanel

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 *MHT tools* or the *MHT system* in this report. A key goal of the MHT system is 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 provide direct care to patients. CCs manage the MHTAV panel of patients as described below and were supported by the MAs who assist the CCs with patient education, collection and summaries of patient home monitoring data (blood pressures and blood sugars), and administrative tasks. MHT includes a range of information that can be viewed for an individual patient or at the population level. At the patient level, this includes demographic information, the patient's condition or disease, and a POC. At the population level, a dashboard shows aggregated statistics for selected indicators, with key statistics displayed at the top to provide a snapshot of the population. The dashboard information can be reviewed or manipulated to identify subpopulations of interest.

Care coordinator activities are driven by a worklist (Figure 3), which shows patients with alerts that were either clinically driven (such as an elevated home blood pressure reading) or process driven (such as a patient who is due for an annual foot exam).

Figure 3. MHT Worklist

Cnt	MR#	Patient Name	Age	Sex	CC	Status	Heart Failure	Diabetes	Hypertension	HomeBP	PCP	Next PCP Visit	Alerts	Actions
				F		ACTIVE			1b (Surv)				HiBP:(02/24)	Actions
				F		ACTIVE	1a	3b	3b			2014/07/09 13:40	HiBP:(03/26); POC:(03/19, 03/19 *)	Actions
						ACTIVE		2b	3a				POC:(2013/06/10 *, 2013/06/24 *)	Actions
						ACTIVE			1a				WestMedSurv:(06/12); WestPromote: (06/17)	Actions

A POC (see Figure 4) is created for each patient enrolled into the MHTAV program. The POC can be thought of as a form for monitoring diabetes, hypertension, and congestive heart failure, used over a time period. If a patient has multiple chronic conditions, the software displays an integrated presentation of all of the plans of care. The POC includes a start and end point for each goal set. Each goal also has a responsible person assigned, and as the patient moves through the goals outlined in the POC, different alerts and actions are directed to the CC or other members of the care team.

The POC is accessible to all clinical staff who can view the EHR for an enrolled MHTAV patient. It contains historical and current information about treatment goals, including medications and lifestyle changes, as well as barriers to achieving treatment goals as noted by the CC. The POC automatically imports clinical data relevant for decisionmaking to manage chronic disease such as blood pressure parameters, laboratory values (HbA1c), weights, although CCs can retrieve additional data from the EHR as needed.

Patients can also contribute information that gets entered into the POC, such as home blood pressure, activity or food diaries, or other clinically relevant information. Those data may be uploaded directly into the POC from the patient portal (if patients have entered them there via their home computer or tablet) or brought to the CC on paper, in which case the CC or the MA will enter the information into the MHT system. The medical assistant (MA) may also support for this task by entering and summarizing blood pressure and blood glucose values (that is, providing averages or percentage of readings at goal.)

Each patient's POC is evolving; both clinicians and care coordinators monitor clinical goals and can recommend goal updates. For example, CCs can document changes to the patient's disease state, actions taken in their care such as medication changes, and barriers to self-care such as economic and home life challenges. Each active POC, defined as having outstanding alerts or goals, must be updated at set but modifiable intervals, typically every 4 weeks. When an update is needed, an alert is generated, and added to the CC's worklist. For example, in Figure 4, beneath "4) Monitoring Goals," the POC displays the most recent blood pressure (BP) submitted by the patient (June 11, 2014) via the patient portal and indicates that the CC needs to send a reminder to the patient, asking them to submit their latest home monitoring data.

Figure 4. Plan of Care

1) Hypertension

Current: Active-engage [Stratification: 2a] View Mode of Care Changing History (see window below)

Surveillance Active-engage

POC Status: Active

HTN Start Date 2014/02/ Approx. Cycle (Wks): Refresh f/u dates

HTN Early Check Date HTN-POC Exp Date

F/U by MA?

1) Short Term Target(s)

Record Date	Record By	Target Name	Target Value	Comment	+
2014/01/15		test			

2) Medication Goals Show History

Record Date	Record By	Event Type	Goal	Comment	+
2014/02/11		Change			

[West] most recent Med Change Survey done date: 2014/06/09
Click here to manage the current 'Med Change Survey' request

3) Testing/Eval Goals Show History

Record Date	Record By	Goal	Comment	+
2014/02/11				

4) Monitoring Goals Show History

Record Date	Record By	Goal	Comment	+

[MHaV] most recent home BP sent in date: 2014/06/11
[West] no home BP sent in yet
Click here to send a new 'Sending Home BP Reminder' request

5) Other Goals

Record Date	Record By	Goal Name	Status	Comment	+

Of note, the software developer who led the design of the MTH tools also worked as a physician in the first clinic to pilot those tools and helped to fit those new tools to clinic workflows. Management policy was also coordinated. For example, a new disease control form (DCF) was established to so that the CC could request that the provider review new information about a patient, and document their decision about what to do next.

Study Purpose and Research Question

Informed by the need for additional information regarding health IT and workflow in ambulatory settings and guided by the theoretical framework provided by the SEIPS and WEM models, the central research question for this study was: What is the workflow impact of implementing health IT-enabled care coordination within six ambulatory primary care clinics?

Section 2. Methods

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 to study six site teams at Vanderbilt University Medical Center (VUMC) affiliated-clinics. These primary care clinics were in different phases of adopting MHTAV, a program to introduce the new care coordinator (CC) role and care coordination activities for several chronic conditions including diabetes. Data collection over a 12-month period was designed to generate a detailed understanding of changes in health IT-workflow interaction for each clinic over time, and across clinics in various implementation phases.

Figure 5 summarizes the study design. Six care coordination site teams were identified. Each care team was composed of a provider (physician or nurse practitioner), a clinic nurse (RN or LPN), a medical assistant (MA), a care coordinator (CC), and sometimes a scheduler. Although care coordinators in this study were licensed as RNs, they functioned in the CC role rather than the clinic nurse role.[*]

For three site teams (1, 4, and 5), the CC and the MHTAV program were already "live" at the start of the study and throughout the 12-month period of data collection. For the other three site teams (2, 3, and 6), the CC and MHTAV program were introduced during the 12-month period of data collection. Observations and data collection occurred in three phases. Phase 2 occurred approximately 6 months after Phase 1 began, and Phase 3 occurred approximately 12 months after the start of Phase 1.

The intent when the study began was to focus specifically on patients with diabetes and the care coordination activities that support diabetes care. However, when data collection began in late 2013, only hypertension (not diabetes) was implemented in participating MHTAV clinics. About halfway through the study, the diabetes functionality began to be implemented. As a result, all of the Phase 1 observations reflected use of hypertension care coordination tools. Nevertheless, many patients with hypertension also have diabetes, so patients were screened for diabetes before they were contacted for participation in the study. However, the CCs in the study were primarily focused on identifying 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 intensified. MHTAV guides to identify high-, medium-, and low-risk patients with hypertension and diabetes, and how actively they should be monitored and contacted, are shown in Appendix A.

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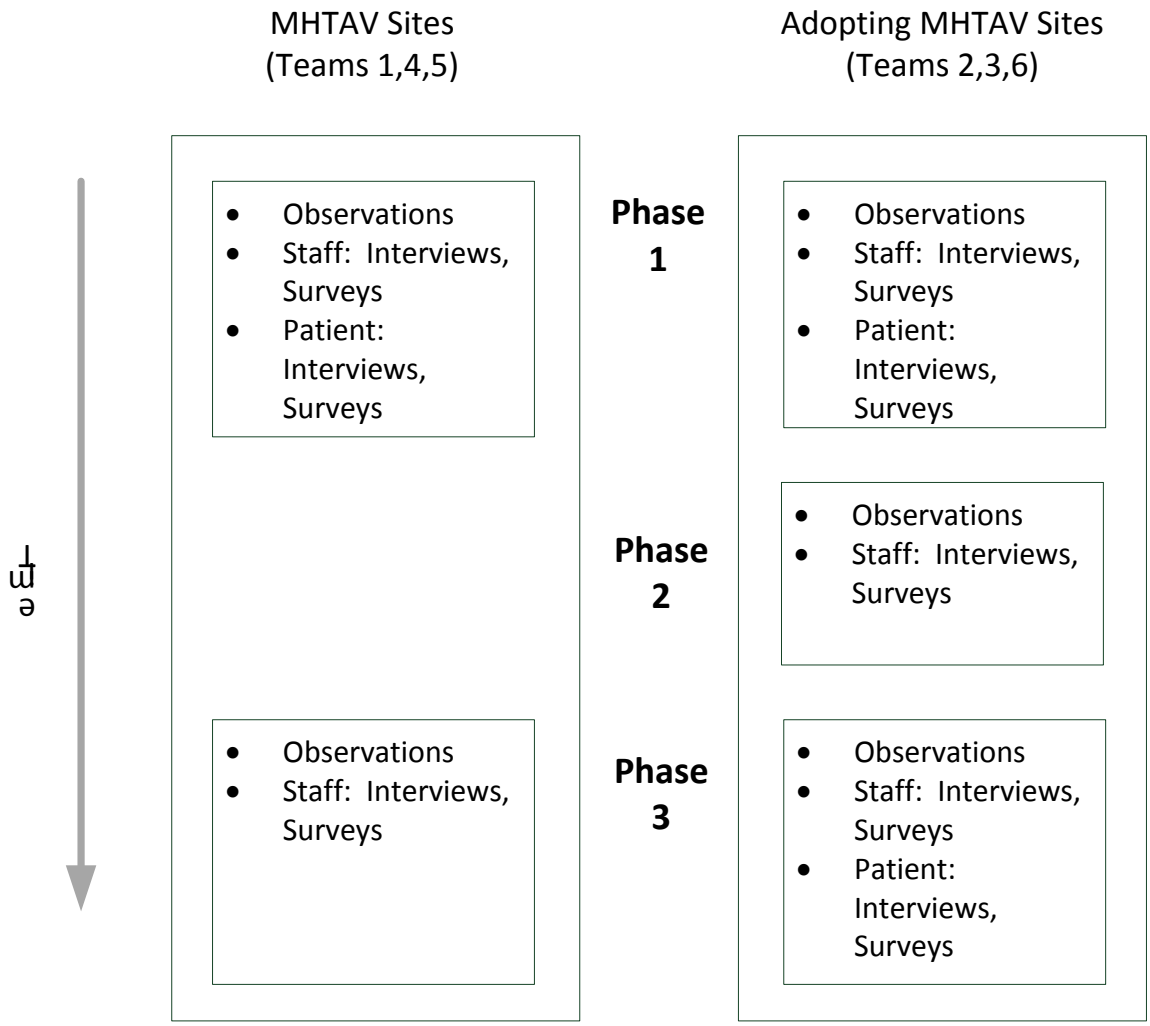
[*] In this report, the term *clinician* is used to refer to a physician (MD), a nurse practitioner (NP), or a clinic nurse (RN or LPN). The term *provider* denotes either a physician or nurse practitioner leading a care team. All providers were either internal medicine or family medicine practitioners. Although each care coordinator was a licensed RN, they are referred to by their CC role and are not included under the term "clinician."

Figure 5. High-Level Study Design



IRB and OMB Approvals

In compliance with the Paperwork Reduction Act, the study was reviewed and approved by the Office of Management and Budget (OMB). A 60-day *Federal Register* notice was published on October 31, 2012 and a 30-day notice was published on January 7, 2013. OMB approval was received on March 19, 2013.

Both RTI and Vanderbilt's respective Institutional Review Boards reviewed and approved the study protocol and instruments.

Recruitment

A purposive sampling strategy was used to identify and recruit six care teams: three that used the MHTAV program throughout the study period (MHTAV), and three in the process of *adopting the MHTAV program* during the study period (MHTAV-adopting). Originally, we had intended to include two care teams that used MHTAV throughout the study, two that were in the process of adopting MHTAV during the study, and two that did not have and did not adopt

MHTAV during the study. However, the implementation timeline for MHTAV was significantly accelerated such that no potential sites would have been without MHTAV at the conclusion of the study. We, therefore, modified our approach.

Project staff contacted clinic staff at each recruited site to ascertain interest in participating in the study. Once a site team was confirmed, an informational meeting for the staff was scheduled.

Data Collection

Data collection activities included: (1) project orientation meeting with staff from each clinic site, (2) direct observation of staff work, (3) individual staff interviews (see Appendix B for interview guide), (4) individual patient interviews (see Appendix C for interview guide), (5) staff surveys (Appendix D), and (6) patient surveys (Appendixes E and F). In addition, the VUMC 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 2.

Data Analysis

To answer the research question, qualitative and quantitative data were analyzed and results synthesized. Qualitative data were analyzed in three phases: (1) open coding, (2) axial coding, and (3) workflow modeling. Quantitative analysis included the scoring of staff and patient survey responses, and reporting of software use. Quantitative and qualitative data, together, supplement one another to help identify complementary themes, resolve conflicting findings, and provide rich detail to support conclusions about health IT—workflow interactions—in general, across implementation phases.

Dedoose

Once in an electronic format, data collected through the staff orientation meeting, direct observation, individual interviews, and artifact/spatial data collection (rows 1, 2, 3, 4, and 8 in Table 2) were uploaded to Dedoose for analysis. Dedoose is a Web-based qualitative and mixed-methods data analysis cross-platform application designed to support collaborative data analysis activities.

Table 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 semistructured interviews	Practice staff participating in direct observations	Responses to interview guide questions gathered from practice staff
4 Patient semistructured 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;[15] 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;[16] 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

Phase 1: Open Coding

Open coding consists of iterative cycles of coding and data collection performed during and after each observation period. During earlier cycles of coding, researchers identified data elements to attempt to capture in later cycles of data collection.

As more data were added, the coding structure was refined, and higher level themes were identified. Open coding concluded when researchers assigned codes to all data deemed relevant to the research question.

During open coding, researchers assigned codes to "chunks" of textual data, using the content of the data and the theoretical frameworks to determine the label for each code, which then became available for all coders.

Phase 2: Axial Coding

After completion of the open coding process, analysis moved to an axial coding approach.[17] Axial coding adds depth and structure to the constructs (codes) previously developed in the open coding phase, by synthesizing lower-level constructs into a more integrative theory. During the axial coding process all qualitative data were reviewed again and categorized according to a determined theoretical framework, the SEIPS model combined with the Workflow Elements Model (WEM). The combination of SEIPS and the WEM provided the structure for assigning data and codes to the categories in Table 3.

Table 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, StarPanel, 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

Sources: Holden et al.[13]; Unertl et al.[12]

Applying this framework to diabetes 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.

Phase 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. The modeling process is based on concepts from soft systems methodology[18] and hierarchical task analysis.[19] 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 phases, researchers identified the overall flow of CC work and each subprocess involved in CC 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 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.

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)[20] survey were used to evaluate user perceptions and acceptance of technology. 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.

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.

Data Synthesis

Data synthesis compared and contrasted all health IT and workflow-related data gathered over six sites during two or three (depending on the site) observation periods over 12 months. As detailed in the Research Plan, 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 used to examine the strength of support for the identified themes, conflicts in the findings, and the development of final conclusions. Table 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 4. Description of Research Product(s) for Each Analysis Activity

Analysis Activity	Source of Data	Product
A. Workflow diagramming to identify and describe workflows	Semistructured 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	Semistructured 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

Interactions Between Health IT and Workflow

The technology matrix will capture clinical workflows that comprise care coordination (columns), and the health IT features or components (rows) 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 assessed by looking at an entire column or set of columns (alignment of multiple IT components with individual workflows of a work activity.

Section 3. Findings

Data Collection and Sites

Data collection across the three study phases and six site teams yielded a total of 24 staff interviews, 57 patient interviews, and 40 site team observations that formed the qualitative dataset used in the analysis for this project. Staff completed 28 surveys. Each survey included the 49 items from the Technology Acceptance Model (TAM) survey.[15] Patients completed 57 surveys that included the Summary of Diabetes Self-Care Activities (SDSCA)[21] and the Patient Activation Measure (PAM).[16] System data monitoring user access to the Plan of Care (POC) was obtained. The primary study findings are presented in this section, followed by findings that provide additional context.

The six study site teams included a single on-campus medical office (medium-sized) and five off-campus primary care offices (small) in Tennessee ranging from two to eleven clinicians. Several sites that were initially approached declined to participate, and as described earlier, the acceleration in implementation of the MHTAV program also impacted site and team recruitment (see ***Table 5***). Site team 1 was included in the study because, as the first to implement the MHTAV program, it represented the most established work system to study. Even though the clinic is medium in size, the site team we studied was similar to other site teams – and included 4 roles. Two different site teams, 3 and 6, were in the same clinic location (one was physician-led, and one was nurse practitioner-led).

Table 5. Study Sites

Site Team	Attending MDs	Resident MDs	NPs	Setting	MHTAV Adoption**	CC Proximity
1	35	93	0	Urban	April 2010	Yes, in separate office, 5 days/week
2	2	0	0	Rural	March 2014	Yes, on-site, 2 days/week
3*	4	0	3	Urban	November 2013	Yes, on-site, 5 days/week
4	10	0	1	Suburban	October 2012	Yes, in office on different floor, 5 days/week
5	11	13	0	Suburban	May 2013	Yes, in separate office, 5 days/week
6*	4	0	3	Urban	November 2013	Yes, on-site, 5 days/week

MD = physician; NP = nurse practitioner; MHTAV = My Health Team at Vanderbilt; CC = care coordinator. *Two different teams were observed at the same clinic. **MHTAV site teams were 1,4,5; MHTAV-adopting site teams were 2,3, and 6.

While the study design called for the collection of process outcomes data including HbA1c and LDL for the site team practices, the study team elected not to report the data obtained because it represented the entire practice, rather than the site team that was studied.

Overall Impact of Health IT on Workflow

The overall impact of health IT on workflow was mixed. Depending on the specific task, technology, and user, the use of health IT ranging from strongly enabling or enhancing workflow to becoming a barrier to it. Because care coordination activities encompassed so many different tasks, workflows, and tools, workflow diagrams (or information flow, in one case) were used to summarize common activities across the six site teams. Technology matrices were used to summarize the interactions between tools and workflows.

Each technology matrix was developed around the concept of "alignment." During data analysis, alignment emerged as a useful concept for assessing health IT impact on workflow, because (1) workflow and the organizational context changed over time, (2) workflow varied among the teams studied, and (3) technology was adapted to meet the needs of the workers studied. Alignment, or "fit," could be applied to multiple dimensions of health IT and workflow, and was used to describe how health IT supported or impeded user workflow.

We considered interactions between multiple aspects of the health IT, including user interface design and system workflow elements (for example, forms or alerts that flow from one participant's action to another's queue), tasks as performed by workers, and management policies. When alignment was good, we observed that health IT had a positive impact on workflow. Where alignment was poor or varied, we observed that health IT had a mixed impact on workflow. Impact could not be assessed as a one-dimensional measure (good or bad, high or low) because it varied by role, over time, and in different clinical settings as discussed in the following sections.

Health IT Impact for Different Roles

The majority of the findings describe the work practices that comprised the MHTAV program, focusing primarily on care coordinators (CCs), and examine technology alignment with those work practices. We focused primarily on the CCs because their role served as the centerpiece of the MHTAV program. In collecting and analyzing data on other team roles, we found that physicians, nurses, medical assistants (MAs), and patients were part of the MHTAV program, primarily via their interaction with the CC.

Care coordinators and medical assistants reported that that the new MHT tools supported their work within the MHTAV program. This work—assembling a group of patients at risk for a specific clinical outcome and implementation of an integrated, monitored POC—arguably could not be accomplished effectively without *both* the new software and preexisting health IT. While many health care activities, such as ordering laboratory tests and sending clinical communications, predated the introduction of the MHTAV program, key MHTAV activities such as enrolling patients, monitoring their progress, and updating a plan of care, *did not* exist before the new program was introduced. New work, new roles, and new health IT to support MHTAV were introduced at the same time.

Physicians and nurse practitioners (providers) impacted by the MHTAV program and MHT tools primarily reported an increased workload. Increased nonvisit communication between patients and CCs generated increased message traffic from CCs to providers. Information that the CCs entered in the new DCF prompted a few minutes of *provider* time for decisionmaking on each patient, leading, in some cases, to provider frustration because of a noticeable increase in workload associated with hundreds of patients newly enrolled in MHTAV.

Clinic nurses experienced increased coordination requirements, such as the need to remember to engage the CC for certain patients (enrolled in the MHTAV program to monitor diabetes or hypertension), but not others. Even the presence of a prominent indicator next to the patient's name in the EHR (marking the patient as an MHTAV participant) did not assure coordination among the care team. Clinic nurses were often left out of the communication loop between the CC and the provider, making it more difficult for them to stay current on communications and actions with some of their patients. For example, a clinic nurse reported that she received mailed home glucose readings from a patient and immediately placed them in the

doctor's inbox for review, but then remembered days later that she *should* have given them to the CC instead.

Health IT Impact Over Time

During the study, alignment between the MHT system and user workflows was observed at times to shift, such as when diabetes care coordination tools were launched, expanding the MHTAV program. Other changes in alignment involved tools outside the MHT system, such as the implementation of an interactive voice response (IVR) system for specific telephony tasks. The IVR system was not well integrated into the MHT tools, which may have contributed to CCs' lack of enthusiasm for the IVR. Changes over time also occurred as each site team learned how best to notify the CC of patient care activities and learned the communication preferences of individual team members.

Health IT Impact in Different Contexts

Study sites included different organizational contexts, including a small rural clinic, a suburban clinic, two clinics that included nurse practitioners as providers, and clinics with physical layouts that differed substantially from the initial pilot MHTAV program clinic. These new contextual factors produced conflicts, revealing constraints in the way the MHT tools were designed, how they interfaced with existing EHR tools, and the MHTAV program itself. For example, in the rural site, the CC split her time between two clinics. She relied heavily on messaging to communicate with providers, as did other CCs who were not co-located with the rest of their team. When CCs worked in a separate office or on a separate floor, they used the virtual online whiteboard extensively to identify when their patients with appointments had been checked in and were available for the CC to make a quick in-person connection.

Health IT Impact on Workflow in Key Work Domains

This study identified seven domains of activity central to the work of care coordination, and around which the study results are organized.

Five 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

Two of the activity domains *supported* the primary work of CCs:

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

Findings from each of the seven areas are presented next, including 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.

Establishing and Maintaining Relationships With Patients

The first type of primary work performed by CCs was 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 (see Appendix A) 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 initial 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 to 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 one 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.

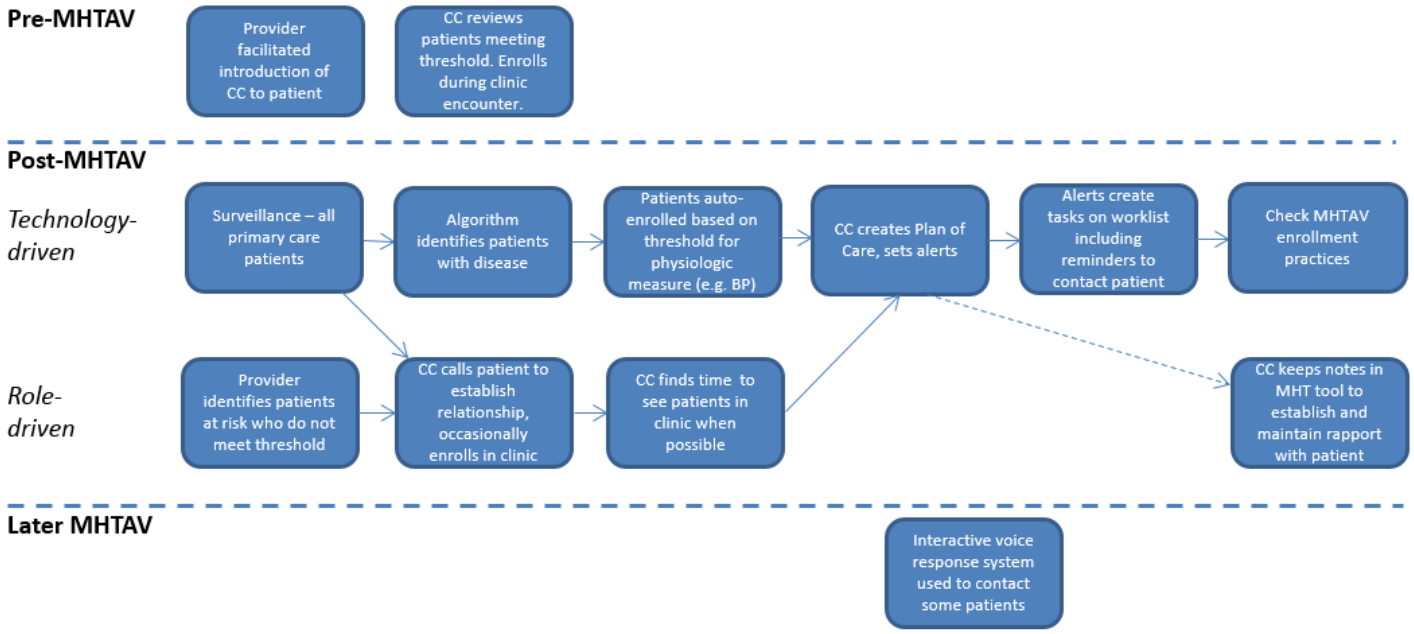
However, advances in technology did not always support maintaining patient relationships. For example, when auto-enrollment replaced the need for a face-to-face enrollment meeting with the patient, the CCs felt that their ability to initially engage the patient, and maintain strong engagement, suffered. They stated that the ability to see patient 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 6 and Table 6 present the workflow diagram and technology matrix for establishing and maintaining relationships with patients. Figure 6 illustrates 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.

Figure 6. Workflow Diagram: Establishing and Maintaining Relationships with Patients



CC = care coordinator; BP = blood pressure; MHT = My Health Team; MHAV = My Health Team At Vanderbilt

Table 6. 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*
Auto-enrollment	Patients are automatically added to CC's panel based on collected vitals and stratified according to the protocol. *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*

Table 6. Technology Matrix: Establishing and Maintaining Relationships with Patients (continued)

Relevant IT Resources or Attributes	Workflow: Establishing and Maintaining Relationships with Patients	
	Activity: Enrollment/Auto-Enrollment	Activity: Building Rapport with Patients
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 middle section of the diagram in Figure 6 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.

Establishing and Maintaining a Plan of Care (POC)

The second type of primary work performed by CCs was establishing and maintaining a POC.

During the early stages of the MHTAV program implementation, CCs generated a POC after their first visit with the patient, guided by protocols shown in Appendix A. Patients visiting the clinic for a routine appointment were often introduced to the CC by the clinic nurse, or scheduled for a followup phone call or visit with the CC if needed. The POC focuses mainly on patient clinical data and is adjusted in collaboration with the patient's provider (MD or NP) over time as needed. This POC includes the recommended intervals for patient home readings, as well as medications used to treat the patient's condition(s). Face-to-face meetings between CCs and patients were far less common in later phases than in the earlier phases of the MHTAV program

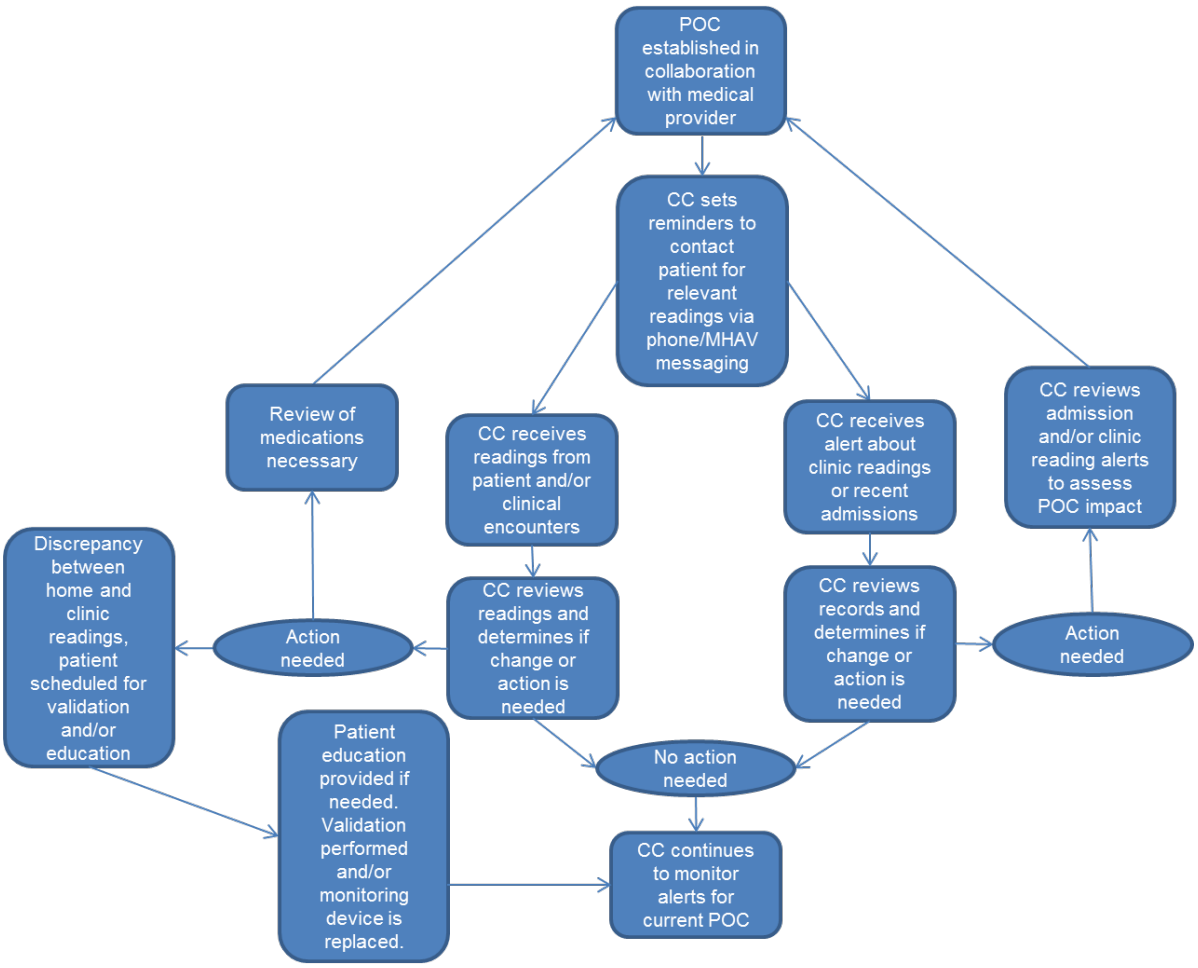
implementation. (Upon implementation, auto-enrollment was a synchronous event based on system surveillance and provider "referrals." Later, enrollment was mostly asynchronous; the system applied statuses to patients via surveillance of vital statistics.) In both instances, creation of the POC was triggered by biometric readings (for example, blood pressure) taken in the clinic and by automated review of the current medication regimen of the patient. The CCs viewed and edited the POC on a regular basis.

The MHT system allows the inclusion of patient-collected data from home as well, allowing CCs or MAs to review and "promote" (into the EHR) the data that were entered through the patient portal or via the IVR system using a patient feature called the "journal." In addition to informing the CC about specific aspects of the patient's health status (for example, blood pressure control), these readings told the CC how closely the patient followed the monitoring schedule established by the POC. These data also assisted the CC in determining whether the patient needed educational support or if home monitoring equipment (blood pressure cuff, glucometer) needed to be validated or replaced. These options were considered when home readings varied greatly from readings collected during clinic visit(s). In order to validate home monitoring equipment, patients were required to bring their equipment to the clinic to ensure accuracy, which ensured that patients were using acceptable home equipment to take readings. If the device(s) were found to be inaccurate, the CC could, in some instances, replace home monitoring equipment such as blood pressure cuffs and/or glucometers. Such replacement depended on patient need as well as available stock.

The MHT system alerts notified the CCs via their worklist if the blood pressure or blood glucose parameters established during the POC were exceeded during a clinic visit. The CC would then determine whether or not actions were needed to help the patient align with the POC, or whether an adjustment to the POC was needed (such as medication changes, more frequent blood pressure readings, lifestyle changes, etc.). If needed, an adjustment to the POC is initiated.

Figure 7 and Table 7 present the workflow diagram and technology matrix for establishing and maintaining a POC for the patient.

Figure 7. Workflow Diagram: Establishing and Maintaining a Plan of Care



POC = plan of care; CC = care coordinator.

Table 7. Technology Matrix: Establishing and Maintaining a Plan of Care

Relevant IT Resources or Attributes	Workflow: Establishing and Maintaining a Plan of Care (POC)	
	Activity: Establishing a POC	Activity: Maintaining/Changing a POC
Alerts and reminders populate the CC worklist	POC establishment driven by patient readings (from clinic) and collaboration between the CC and provider. *Good alignment*	Reminders to call/message patients or connect with them in clinic regarding home readings. BP readings create alerts to CC when above threshold established in conjunction with physician. Facilitates collaboration between CC and provider. *Good alignment*
Disease Control Form (DCF) tab (MHT dashboard)	Displays information about patient, including the next appointment and relevant readings. *Good alignment*	DCF shows status of patient and allows CC to update status based on information received from communications with patient. Used to communicate with physician, prompting action to manage POC. *Good alignment*

Table 7. Technology Matrix: Establishing and Maintaining a Plan of Care (continued)

Relevant IT Resources or Attributes	Workflow: Establishing and Maintaining a Plan of Care (POC)	
	Activity: Establishing a POC	Activity: Maintaining/Changing a POC
POC Support tab (MHT dashboard)	Used to establish a POC with the physician. Displays goals established by physician regarding medication, monitoring and/or education. Most CC work takes place in this tab in the MHT tool. *Good alignment*	"Actions" entered into POC Support screen, populating a "POC Support History". This records all interactions performed by CC to maintain or support POC. "Actions" text window is very small and requires concise composition on behalf of the CC to maintain clarity. Actions and other information entered in this tab do not populate other tabs in the MHT tool, making it time intensive for CCs. *Poor alignment*
Journaling tab (MHT dashboard)	Contains information about patient journaling via MHAV, and allows manual input of readings sent by the patient via postal mail to CC/MA. Also contains information for IVR phone system entered readings. *Good alignment*	Information from this tab assists the CC in determining if the patient is following the POC by taking readings as suggested. This information may also assist the CC in determining if a patient may need educational intervention and/or need medical equipment or validation of existing medical equipment (BP cuffs, glucometers). *Good alignment*
Utilization Data tab	Displays upcoming and past appointments for patients on the CC's panel. Does not display specialist appointments, only PCP and hospital admissions. Assists CC in knowing when the patient is scheduled to visit the clinic. *Moderate alignment*	Allows CCs to see when patient is scheduled to visit the clinic, and can support face-to-face encounters. *Good alignment*

BP = blood pressure; CC = care coordinator; DCF = disease control form; IT = information technology; IVR = interactive voice response; MA = medical assistant; MHAV = My Health At Vanderbilt; PCP = primary care provider; POC = plan of care.

Collecting and Analyzing Home Monitoring Data

The third type of primary work performed by CCs was collecting and analyzing home monitoring data.

Collecting home monitoring data such as blood pressure and blood glucose readings from the patient was not a completely new process. Clinicians from all of the site teams had asked patients to obtain and share home readings in the past. However, when the CCs were assigned to focus on the task, the volume of home readings increased and a new infrastructure was needed to collect and process them. In general, enrolled MHTAV patients were asked to monitor blood pressure and/or blood glucose during their initial meeting with the CC, and CCs ensured that home monitoring equipment was satisfactory, occasionally giving patients free glucometers or blood pressure cuffs. When patients had questions about the equipment or there was evidence that the home monitoring equipment was not calibrated correctly, CCs used self-reminders to ensure they connected with patients during a future scheduled appointment. Calibrating equipment and inspecting the procedures used by patients to obtain home readings were tasks that required face-to-face interaction between the CC and the patient.

Home readings were deemed necessary by the provider or the CC if any VUMC-obtained assessment showed evidence of high blood pressure or elevated blood glucose. The CC provided paper logs for the patients to complete and instructions on the duration and timeframe in which to capture the readings (for example, for 1 week before the next provider appointment, or 3 weeks at home after starting a new medication). Patients were instructed to bring readings to an appointment, mail them to the clinic, or submit the readings using MHAV. After patients submitted the readings, MAs reviewed them, calculated averages and ranges, and entered the data into an electronic form in a preliminary status. The CC then reviewed the information and gave it a final status.

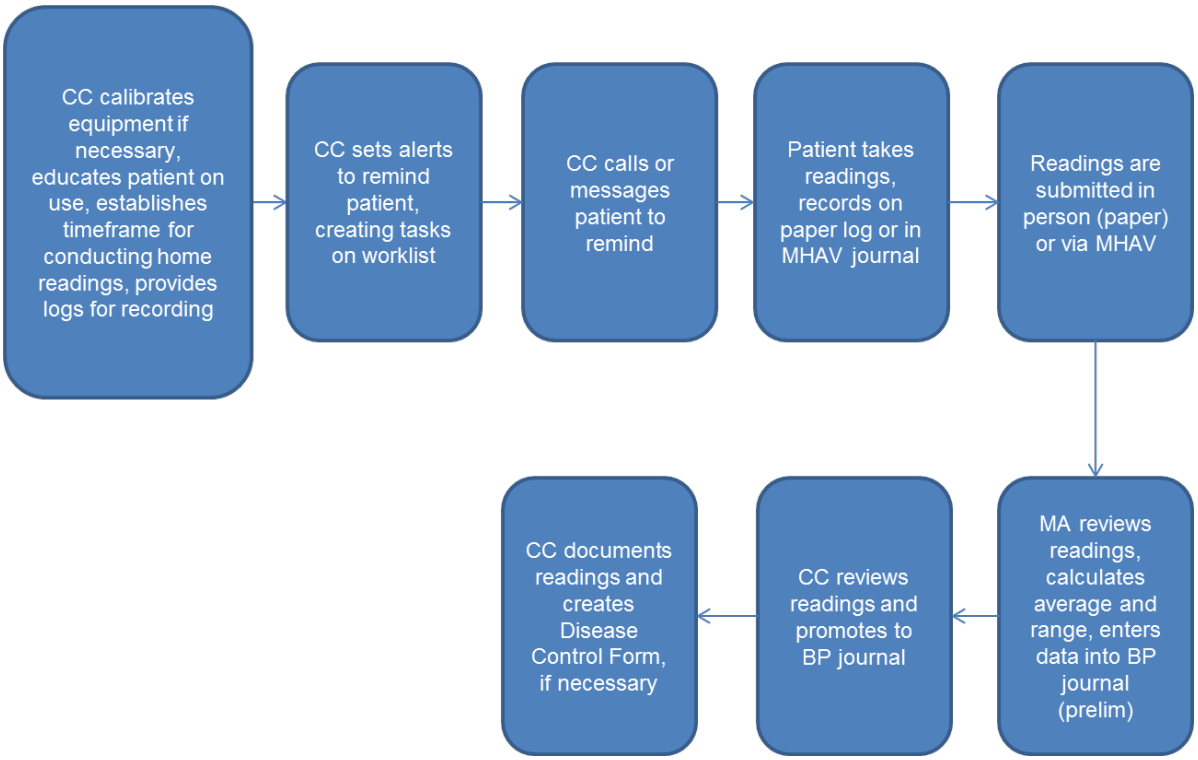
When patients entered their home readings into the MHAV patient portal, CCs began to experience an ongoing source of frustration: the format of the electronic form in MHAV was not the same as the paper forms that patients were given when they met the CC in person at a clinic visit. For example, the paper blood pressure log included a field to enter the pulse rate, but the electronic form with blood pressure data was missing this field. Perhaps because of this discrepancy, patients sent their pulse rate (information that is needed when deciding how to adjust blood pressure medications) through a separate MHAV message or not at all. MHAV did not include space in the journal for blood glucose or weight. To submit these measurements, patients kept a written log and mailed it to the clinic, sent information as part of a freeform message using MHAV, or gave information to the MA or CC at a clinic visit, so it could be entered by them.

The paper data collection logs used for home readings also varied. Paper forms were different among different CCs and were also different from MHAV online forms. For example, one CC used a paper copy of the form which she then modified to incorporate patient information and the correct types of home readings, but did not share this modified form with other CCs.

The CCs often interacted with patients about their home readings, but their interactions were typically much more than just a reminder to obtain readings. CCs would use a conversational approach in their calls with their patients, chatting about the weather and encouraging the patients to take advantage of the nice weather to get more outdoor exercise. They would also inquire about challenges with diet and other health factors before moving into a more technical description of the process of obtaining and reporting home readings.

Figure 8 and Table 8 present the workflow diagram and technology matrix for collecting and analyzing home monitoring data.

Figure 8. Workflow Diagram: Collecting and Analyzing Home Monitoring Data



BP = blood pressure; CC = care coordinator; MA = medical assistant; MHAV = MyHealthAtVanderbilt

Table 8. Technology Matrix: Collecting and Analyzing Home Monitoring Data

Relevant IT Resources or Attributes	Workflow: Collecting and Analyzing Home Monitoring Data		
	Activity: Setting Up Home Monitoring Devices	**Activity: Collecting and Compiling Data**	**Activity: Identifying Actionable Readings and Following Up**
Alerts and reminders	Reminders are used to connect with patients during clinic appointments *Good alignment*	Reminders for both CC and MA to check patient submission of readings *Good alignment*	
Patient portal messaging		Enables multiple pathways— messaging or online journaling—in addition to paper, to acquire glucometer data *Good alignment*	
BP Journal Feature			MA documents readings, CC reviews. BP journal does not have a field for pulse rate, which is captured on the paper form. *Moderate alignment*
Disease Control Form (DCF)			CC creates form to facilitate physician decisionmaking re: medication changes and other therapies *Good alignment*

BP = blood pressure; CC = care coordinator; MA = medical assistant.

Educating and Coaching Patients

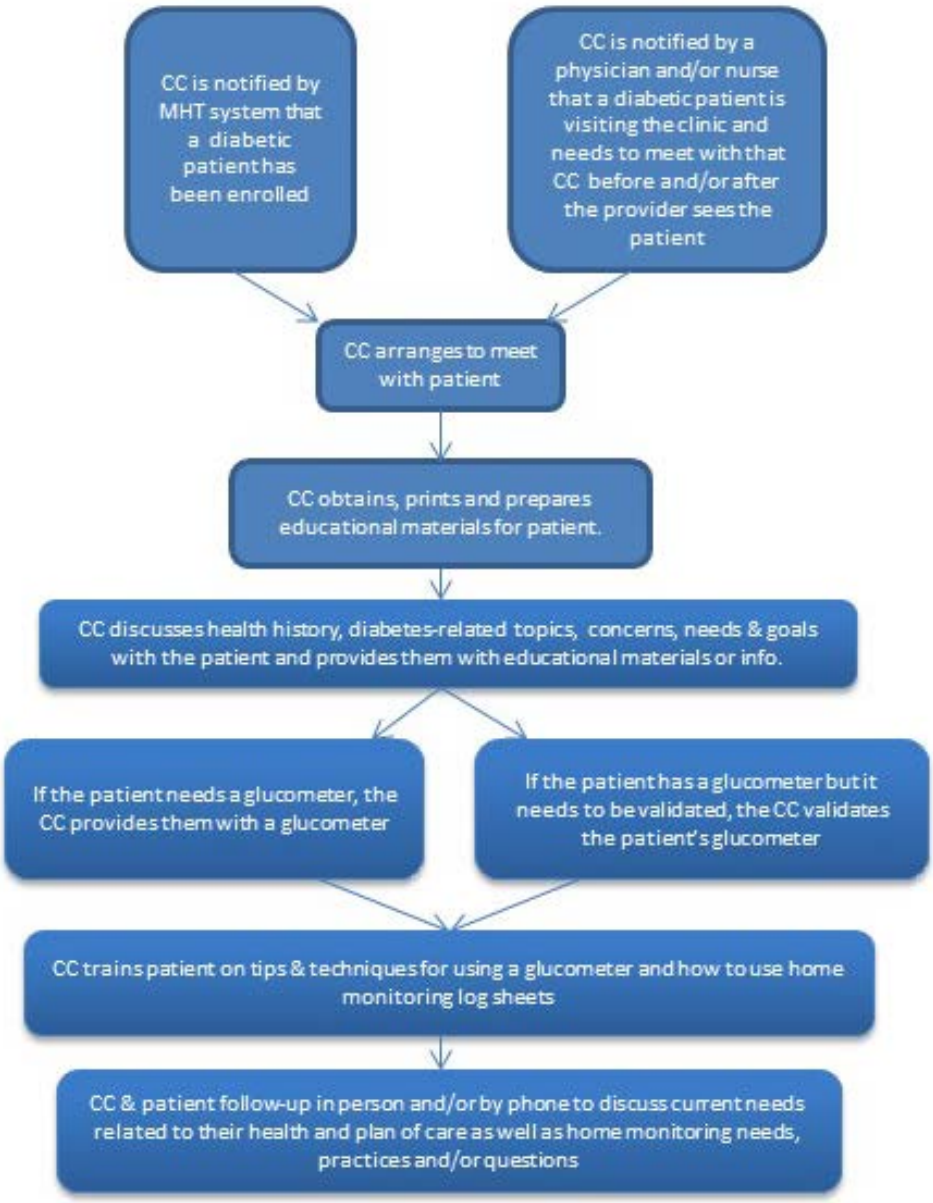
The fourth type of primary work performed by CCs was educating and coaching patients. To engage patients in self-management of their chronic illness and support each patient's participation in the POC, CCs educate patients and provide guidance as a primary job function/activity. They educate patients about insulin and blood pressure medications, diet and exercise, as well as the management and reconciliation of medications. In addition, the CCs instruct patients on best practices for monitoring the health status of their chronic illness (for example, blood glucose testing for diabetic patients) and logging/documenting these measurements. For patients who do not have the resources to have their own glucometer or blood pressure monitor, CCs can provide glucometers or blood pressure monitors so patients can conduct home monitoring. CCs can also validate a patient's glucometer or blood pressure monitor in the clinic if the patient's home measurements are inconsistent and/or incongruent with measurements obtained with calibrated glucometers and blood pressure monitors used in the clinics. To help address any barriers and resolve any issues that may affect a patient's adherence to the POC, CCs also try to help identify any services (for example, local courses regarding a patient's health issues, needs, or concerns) and/or resources available to their patients and inform their patients accordingly. CCs described an important part of the process, engaging the patient in conversation to learn what information, and possibly, misinformation they already had, such as in performing blood sugar testing or how to take their medications. They said that medication reconciliation–finding out exactly what the patient is taking–can be a time-consuming part of the interaction.

Health IT plays an important role in supporting the educational role of CCs for their patients. The EHR provides essential information about how medications are, and should be, taken by the patient. Educational materials are also made available via the EHR. During initial implementation of the MHTAV program, educational materials for patients with diabetes and hypertension were developed internally and made available via the MHT system for use by each CC. Later, licensed material from the Krames patient education database was placed in a diabetes education folder online for use by the CCs. Most CCs also prepared printed packets of this educational material to have available for patients when needed.

CCs also rely heavily on the Internet for information, including local services and resources, to support patient education. For example, some CCs frequently use *Medline Plus* as a reference for medication information to help patients with medication management and/or reconciliation. However, as CCs learn about local resources (both from their own searches and from other patients), there is no database, repository, or other mechanism they can use to share the services, resources, and ideas. This lack of a common sharing mechanism results in inefficiencies and lost opportunities among CCs.

Figure 9 and Table 9 present the workflow diagram and technology matrix for educating and coaching patients.

Figure 9. Workflow Diagram: Educating and Coaching Patients



CC = care coordinator; MHT = My Health Team

Table 9.Technology Matrix: Educating and Coaching Patients

Relevant IT Resources or Attributes	Workflow: Educating and Coaching Patients Activity: Creating Educational Materials/ Tools for Patients	Activity: Contacting Patients (In Person or by Phone)	Activity: Training and/or Counseling Patients
Shared/standardized education folder/module on database	Educational materials (for example, Krames educational modules) for patients are accessed, via the My Health Team (MHT) software or an easily accessible database, and prepared ahead of time (for example, preprinted packets). *Good alignment*		
My Health Team (MHT) alerts & reminders		MHT worklist, alerts and/or schedule help CCs determine if/when (or schedule an appointment with) a patient is coming in and there is an opportunity for patient training. *Good alignment*	After receiving an alert or reminder, CC talks to patient and/or checks documentation to determine and address information needs of the patient and then takes the opportunity to inform/teach and/or coach/counsel them accordingly. *Moderate alignment*
Internet materials (PDFs of educational modules)	Internet searches for certain conditions (for example, diabetes, CHF), medications, issues, and/or resources available (local courses or services offered, such as dental services or discounts) allow CCs to find information related to any of their patients' needs or inquiries. *Good alignment*		CC prints out and disseminates materials/information resulting from the searches to a patient (by phone, e-mail, and/or in person) and discusses the materials and issues with the patient and/or coaches/counsels them, if appropriate. *Moderate alignment*
Shared educational materials, lists of resources (for example, local courses or services), needs, ideas and/or inquiries	None currently exist on local server, database or software/tools. *Poor alignment*		

CC = care coordinator; CHF = congestive heart failure; MHT = My Health Team

Coordinating With Other Clinicians and Patients

The fifth type of primary work performed by CCs was 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 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 10 and Table 10 present the workflow diagram and technology matrix for coordinating with other clinicians and patients.

Figure 10. Workflow Diagram: Coordinating with Other Clinicians and Patients

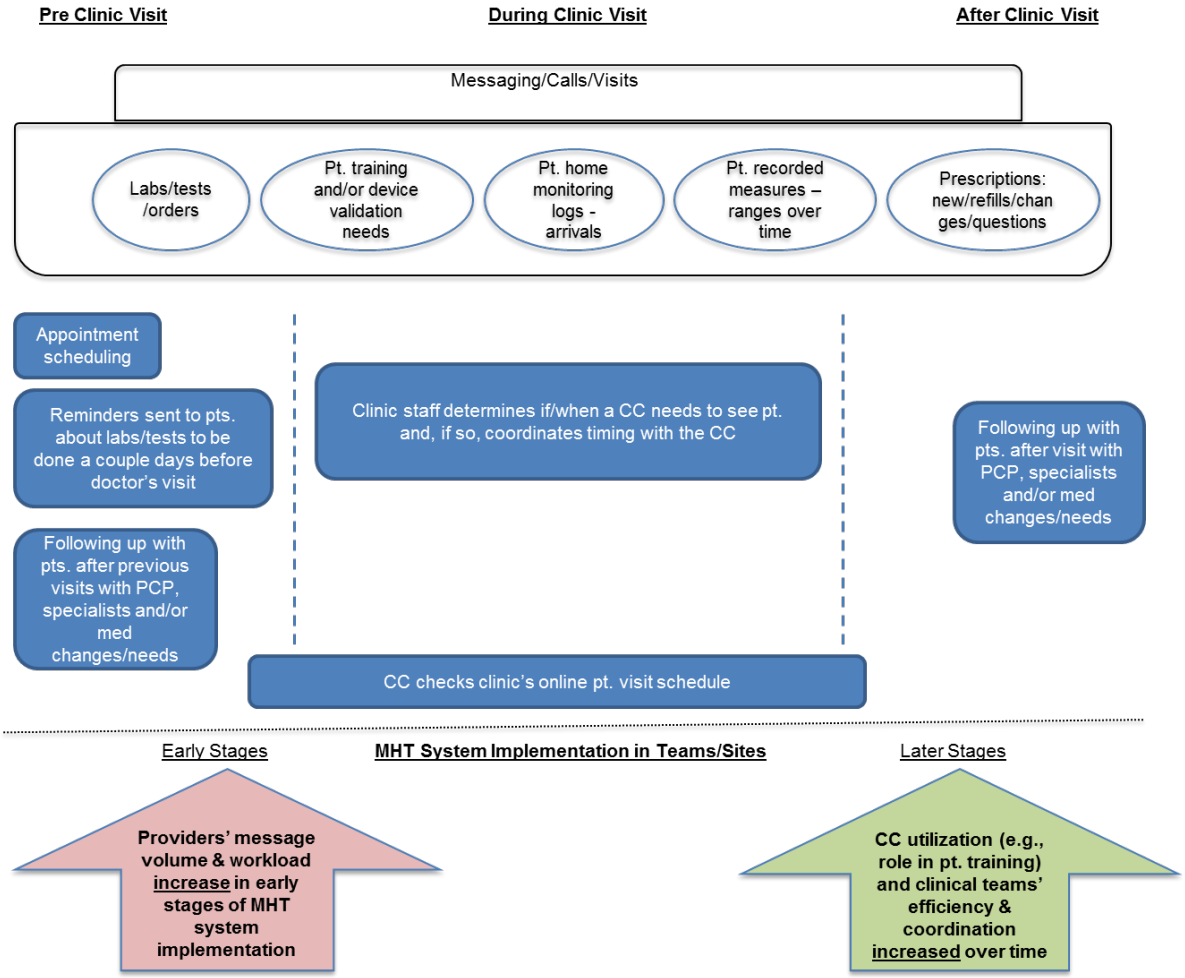


Table 10. Technology Matrix: Coordinating with Other Clinicians and Patients

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: Message basket/MHAV 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* Messages sent/received to coordinate the best time for the CC to see the patient are often not received in time. *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*

Table 10. Technology Matrix: Coordinating with Other Clinicians and Patients (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; MHAV = MyHealthAtVanderbilt; MHT = My Health Team; Pt = patient

Searching for Information to Support Decisionmaking and Action

Searching for information to support decisionmaking and action is the first of two activities CCs perform to support the primary work of care coordination described above.

CCs spent much time searching medical records, results, notes, and other information to investigate worklist alerts or high home readings from patients. They found explanatory information in various places—such as in a specialist's note (patient was being placed on steroids), in a primary care note (patient was not taking medications due to insurance problems), or in records of a hospital admission. The CC's frequent goal in searching for information was to construct an explanatory narrative related to the event (such as high blood pressure or high blood sugar) that made sense to the CC before contacting the patient or developing a message for the provider. For example, the narrative might reveal that all of the patient's home readings had been normal, and that the only abnormal reading was taken during the patient's visit to the Pain Clinic to receive therapy for chronic pain. Fact finding was essential, and often led the CC to recommend that the physician follow up at the next appointment, and not intervene between visits for one abnormal reading.

To organize a variety of sources of data, including conversations with patients, all of the CCs took paper notes about potentially relevant findings in their search. Figure 12 depicts a typical paper. This CC took care to avoid attributing data (for example, blood pressure values) to the

wrong patient by drawing a line through the numbers when she finished documenting and acting on that patient's information. She used only half the sheet of paper at a time, folding it and then flipping it, which also helped minimize wrongful attribution. Writing these notes contributed to the reflection and sensemaking required to construct the most valid narrative. For example, one CC would make a note to review the doctor's note about this patient. The alert appeared on her list because the patient's blood pressure was measured at 160/90 at the Breast Center. The doctor seeing the patient at the Breast Center had taken the blood pressure again in the exam room and it was 148/78. The CC made notes of all these values on her paper. Reading through notes entered by various clinicians, she made notes about stress issues and anemia, both of which could raise blood pressure. The CC is taking information from other notes and writing it on her paper to help her compose her own note later. She has to be very concise with this note, because it is written into the POC "Actions" text box that is only two lines tall. In another example, a CC was searching for information in the EHR. She would take handwritten notes while skimming through previous electronic visit notes to see if there was a medication change, writing down answers to the following questions: (1) Which physician is managing the hypertension?, (2) Is the patient on medications?, (3) When was the last time the patient was seen?, (4) Is the patient monitoring blood pressure at home?, and (5) What are the home readings?.

Other IT tools assisted CCs by reducing their need to search for information, and saved them time. For example, alerts generated by the MHT system (for example, when a patient is admitted to the hospital, goes to the clinic, has a medication change) and self-reminders in the CC's MHT worklist made it easier for CCs to know when to initiate a followup activity such as checking on medication use. The IVR system also automatically contacted the patient (if they consented to be contacted via this method) on a date selected by the CC, and asked about any new or changed medications and any tolerance issues. If there was no patient consent for the IVR, the CC contacted the patient by telephone.

Several limitations with the IVR system were reported by CCs. First, it often did not provide enough specific, contextual information (for example, how a patient's heart rate has been affected by taking a beta-blocker medication known to lower heart rate) because it only asked generic, broad questions without followup questions based on patient responses and/or specific circumstances. Second, the IVR system sometimes called the patients on dates that differed from those the CC requested. Third, if a patient could not hear or understand the IVR, there was no opportunity to ask the system to reword or repeat a question, or obtain help during the IVR call. As a result, patients would not answer, provide incomplete answers, or misunderstand the questions which then required a follow up phone call with the CC to clarify. CCs who felt the IVR data were unreliable or insufficient, called the patient directly to ask about their medication use and experiences. Overall, CCs felt the IVR tool sometimes resulted in doubled efforts and wasted resources. It was not clear how the process of enrolling in IVR was connected, if at all, to identifying patients who might have hearing impairment or difficulty understanding spoken questions asked by a computer.

As described in the Methods section, because the Search for Information work activities were primarily searching and sensemaking, this activity contains workflow (searching and documenting) and also information flow (gathering and processing information). Figure 11 and Table 11 present the workflow/information diagram and technology matrix for the process of searching for information.

Figure 11. Workflow and Information Flow Diagram: Searching for Information

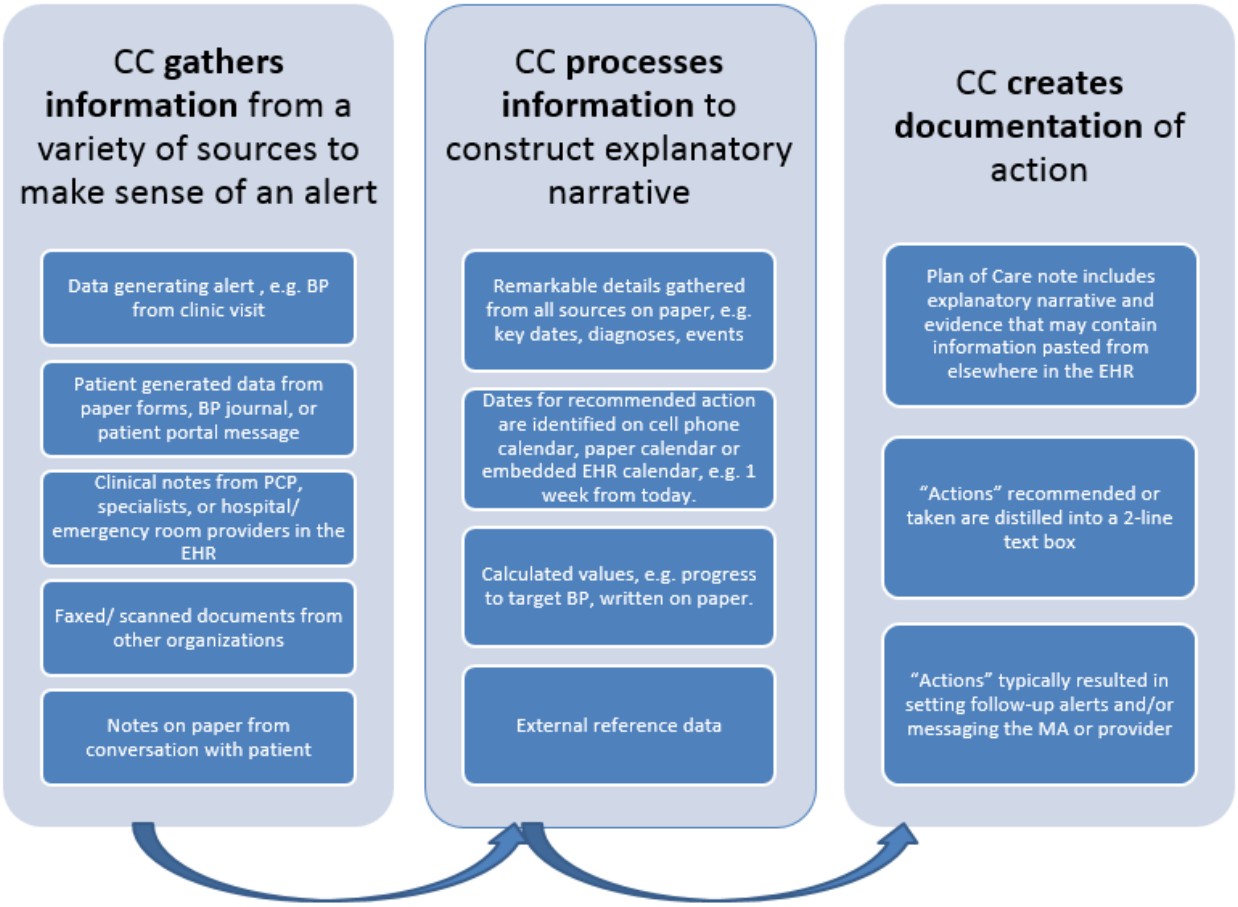


Table 11. Technology Matrix: Searching for Information

Relevant IT Resources or Attributes	Workflow: Search for Information to Support Decisionmaking and Action Activity: Seeking Information	Activity: Making Sense of Information for Documentation and Action
Data sources internal to the organization: Clinic notes Hospital provider notes Hospital discharge notes Medication lists Prescription information Appointment information Messages from clinicians *Schedule information	In systems inside the organization, the CC and staff knew how to find the information they needed, and how to triangulate sources, e.g. comparing doctor's note with prescription information to determine if a medication had been prescribed. Lists of notes that summarized "clinical communications," that is, discussions with patients, sometimes became voluminous, and contained important "buried" information such as dose changes. * In one case, a clinic nurse maintained her login credentials to the clinic scheduling system from a previous role, and used that system to help a patient get seen in another clinic. *Moderate alignment*	• Data from systems inside the organization could be pasted for use in documentation. Example: one CC often copied the medication list from the previous clinic visit into her note, to provide support/evidence for the action she was carrying out. *Good alignment* • All of the documentation was available electronically (either in the EHR or scanned); that is, no paper files had to be pulled when the CC was documenting on a particular patient, and the only non-electronic source data were notes from phone calls made during the documentation session. However, the system did not facilitate multiple windows being open on different computer screens, e.g. the POC on one screen and the last clinic note on another screen so both could be viewed at the same time. This resulted in paper notes being used to assemble the information necessary for documentation and decisionmaking. *Moderate alignment*
Data sources internal to the organization: (continued)		• The box/area for inserting documentation of "Actions" was small, requiring the CC to gather information, make sense of it, then distill it into a very short (2-line) paragraph. *Poor alignment*
Data from partner organization accessible electronically via the Internet: discharge summaries and some test results	Certain data were available electronically from a close regional partner hospital. Good alignment	
Data from other health care organizations faxed and scanned into the EHR: e.g., hospital discharge paperwork, insurance care coordinator reports, or diabetes education reports	Information was often faxed or mailed to the clinic and scanned into the record. Information from other providers has become more difficult to obtain given HIPAA regulations; currently a form is completed and faxed. Information is relatively easy to find once it is scanned in. Multiple participants reported that personal relationships facilitated access to better information, for example, physicians with relationships at other hospitals, clinic nurse identifying high school friend as the diabetes educator at a hospital in the next county. Scanned documents were sometimes hard to read. *Moderate alignment*	

Table 11. Technology Matrix for Searching for Information (continued)

Relevant IT Resources or Attributes	Workflow: Search for Information to Support Decisionmaking and Action	
	Activity: Seeking Information	Activity: Making Sense of Information for Documentation and Action
Information from the patient: Face-to-face conversations Phone calls Messaging in the patient portal Patient entry of home monitoring data into an electronic log (BP Journal) Paper logs mailed or brought in by the patient	Information was typically recorded on paper during phone calls. Paper logs mailed or brought to the clinic were quickly entered into the BP journal by the MA. One CC was observed talking with a patient on the phone and typing home BP readings directly into the BP Journal. *Good alignment*	

BP = blood pressure; CC = care coordinator; EHR = electronic health record; HIPAA = Health Insurance Portability and Accountability Act; MA = medical assistant; POC = plan of care.

Prioritizing Tasks and Planning Work

Prioritizing tasks and planning work is the second of two activities CCs perform to support all the primary work of care coordination described above.

A primary function of the MHT system was to assist the CC in managing tasks. Tasks were triggered by worklist "alerts" (similar to "reminders" in other systems) that were generated either manually by the CC or automatically by the system. These included reminders or notifications in response to (1) high blood pressure or blood glucose, which could be generated from readings taken from any clinic within the medical center, (2) hospital admission, which were generated when an MHTAV patient was admitted to the hospital or the emergency department, or (3) "scheduled", which the CC set for herself or for the MA to follow up on scheduled events such as home readings due from a patient.

As shown in the workflow diagram, CCs prioritized daily work by first focusing on tasks that were (1) time-sensitive (a patient CC needs to meet with has an 8 a.m. appointment that day), or (2) potentially urgent clinical issues, such as a report that a MHTAV patient was seen in the emergency room the previous day. The CCs used their experience as registered nurses to judge clinical urgency and to juggle equally important issues. Later in the day, CCs completed tasks that were due that day (for example, they examined POCs set to expire that day and updated them as necessary).

For example, when planning what to do next after receiving abnormal readings from a patient, one CC described how she prepared for her contact with the patient to schedule a followup appointment. She selected key readings from the text to be able to communicate ranges to the physician and wrote them on the paper in front of her. She wanted to schedule a followup with the patient regarding medications, but the screen she was on in the EHR didn't have a calendar and there was not one on the wall. She, therefore, retrieved her cellular phone and reviewed the calendar feature to identify the best date for followup. She then called the patient, addressing him by his first name and told him he was doing a great job recording his blood sugars. She asked how it was going with the medications. His medication had been increased and she spoke with him about how his body might be adjusting to the change in dose. She mentioned his wife's extensive record keeping and they joked about it. She said she could send more forms and they discussed whether he needed them.

When planning tasks, CCs used a variety of temporal factors, including their own availability and the patient's future scheduled appointments. For example, CCs scheduled alerts for days that they anticipated would be slow. Similarly, in selecting dates to request home monitoring data, the CCs will consider the date of the patient's next appointment, the amount of time needed for a medication change to take effect, and the number of home readings that are needed. The CCs work to also make this process convenient for patients and to fit with the work week. For example, a CC may call on a Friday to remind a patient to start taking readings on Sunday for an appointment later in the following week.

Figure 12. Care Coordinator's Notes on Paper

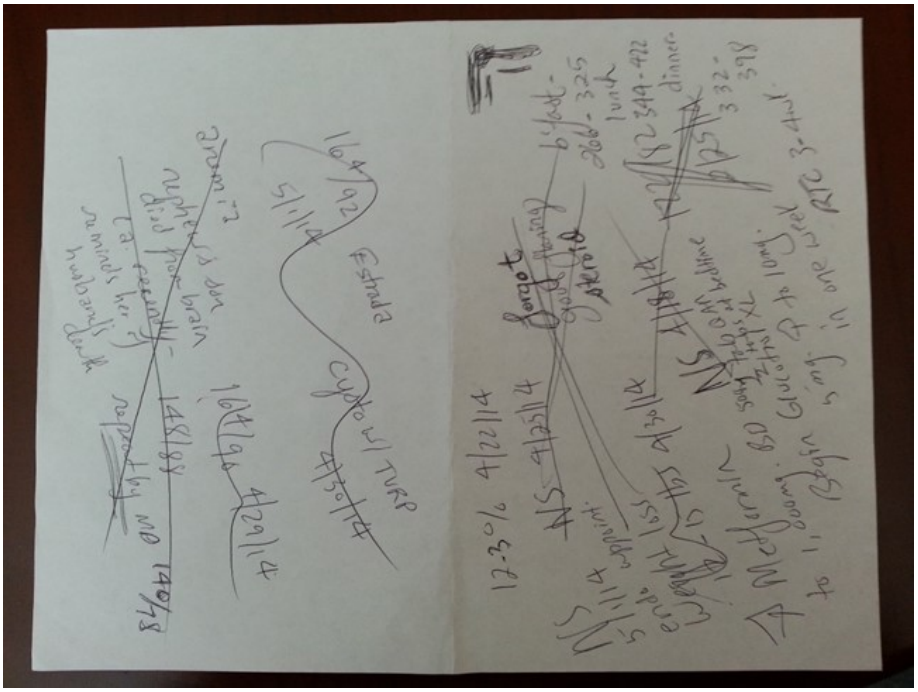


Figure 13 and Table 12 present the workflow diagram and technology matrix for prioritizing tasks and planning work.

Figure 13. Workflow Diagram: Prioritizing Tasks and Planning Work

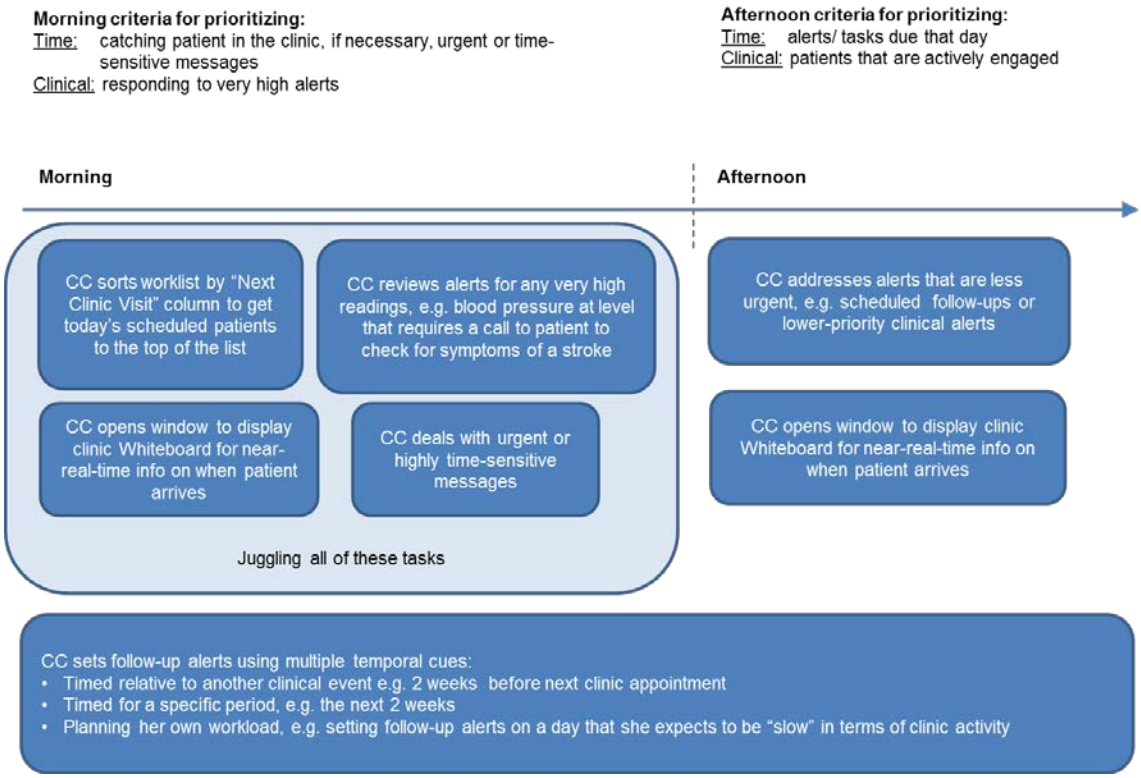


Table 12. Technology Matrix: Prioritizing Tasks and Planning Work

	Workflow: Prioritizing Tasks and Planning Work		
Relevant IT Resources or Attributes	Activity: Identifying Opportunities to Engage Patients Face-to-Face in the Clinic	Activity: Identifying High Priority Alerts	Activity: Setting Alerts
MHT Worklist	List can be sorted by "Next Clinic Visit," enabling CC to see patients with visits in the coming days. *Good alignment*	Alert column displays type of alert, can "show details" to get more information, e.g., specific BP value that triggered alert. *Good alignment*	
Online Whiteboard	CC can see when patients are checked in for their visit, and potentially available for intervention/discussion, however the whiteboard did not always reflect real time status. *Moderate alignment*		
External calendar (wall, cell phone)			Used to identify dates relative to scheduled clinical events (e.g., 2 weeks before next visit), and time frames (e.g., next 2 weeks). Observed to be more useful than MHT built-in calendar. *Good alignment*

Table 12. Technology Matrix: Prioritizing Tasks and Planning Work (continued)

Relevant IT Resources or Attributes	Workflow: Prioritizing Tasks and Planning Work Activity: Identifying Opportunities to Engage Patients Face-to-Face in the Clinic	Activity: Identifying High Priority Alerts	Activity: Setting Alerts
MHT—"next clinic visit"			Events around which followup alerts are scheduled. Does not appear to be updated in real-time. *Moderate alignment*
Outlook calendar			Used to set followup alerts for nonurgent issues. Requires opening a window on a separate computer or screen. *Moderate alignment*

BP = blood pressure; CC = care coordinator.

Additional Findings

The qualitative approach used to investigate health IT and workflow interactions relied primarily on interviews, observations, and thematic analysis of data to identify the seven broad work areas described above. Some additional data were collected to add context to the qualitative findings, specifically to learn about staff attitudes toward EHR technology, patient diabetes self-care activities and patient activation (focus areas for the care coordinator), and utilization data (page views) for the POC.

Staff Technology Acceptance Model (TAM) Survey

The TAM survey was administered to clinical staff to provide context regarding their attitudes toward using the EHR (StarPanel) and MHT software to support their care coordination activities. Selected results from all 28 clinicians who completed the TAM survey are shown in Table 13. Overall, survey results suggested that software tools helped staff to improve patient care (Q8) and collaborate with others (Q11, Q29). Staff reported high satisfaction with the software tools (Q1), future plans to use them (Q5), and satisfaction with using the tools for communicating (Q13, Q14, Q21) and coordinating the care of patients with other providers (Q29, Q46). Lower ratings were given for using StarPanel in new ways (Q48), and in finding ways to adapt StarPanel beyond its original design (Q49).

Table 13. Selected Provider and Staff TAM Survey Responses

Item	Question Text	Average
Q1	Think about the last 2 weeks… To what extent are you satisfied with using StarPanel to coordinate care?	5.0
Q5	Think about the next 3 months… Over the next 3 months, to what extent do you intend to use StarPanel to coordinate care?	5.8
Q8	Think about the last 2 weeks… How much has using StarPanel to coordinate care improved patient care?	5.0
Q11	Think about the last 2 weeks… How much has using StarPanel to coordinate care improved your ability to collaborate with others involved in patient care?	5.3
Q13	Think about the last 2 weeks… How much has using StarPanel improved your ability to communicate with patients to coordinate their care?	5.1

Table 13. Selected Provider and Staff TAM Survey Responses (continued)

Item	Question Text	Average
Q14	Think about the last 2 weeks… How much has using StarPanel improved how well you can communicate with others in your clinic to coordinate patients' care?	5.4
Q21	Think about the last 2 weeks… To what extent does using StarPanel help convey information to others even though you are not working beside them?	5.3
Q29	Think about the last 2 weeks… How much do your colleagues use StarPanel to coordinate care?	5.6
Q46	Think about the last 2 weeks… How much do you currently use StarPanel to coordinate care?	5.8
Q48	Think about the last 2 weeks… To what extent have you found new ways to use StarPanel beyond how you were trained to use it to coordinate care?	3.5
Q49	Think about the last 2 weeks… To what extent have you found ways to adapt StarPanel beyond how it was originally designed to coordinate care?	2.9

TAM = Technology Acceptance Model;[16] 5=Quite a lot; 6=A great deal

Summary of Diabetes Self-Care Activities Patient Survey

Patients were asked to complete the Summary of Diabetes Self-Care Activities (SDSCA) survey as part of this study to provide further context about opportunities for care coordination improvements in diabetes. A total of 57 patients completed the survey in Phase 1 and Phase 3.

Patients reported taking their daily medicines for diabetes over 90 percent of the time, checking their feet daily over 70 percent of the time, eating healthy about 69 percent of the time, and performing a specific exercise activity about 31 percent of the time. No meaningful differences were seen across study phases or study practices.

Patient Activation Measure (PAM)

Patients were asked to complete the Patient Activation Measure (PAM)[16] survey to provide further context about opportunities for improved level of engagement of patients as part of care coordination activities. A total of 57 patients completed the survey in Phase 1 and Phase 3.

They reported taking their daily medicines for diabetes over 90 percent of the time, checking their feet daily over 70 percent of the time, eating healthy about 69 percent of the time, and performing a specific exercise activity about 31 percent of the time. No meaningful differences were seen across study phases or study practices.

Plan of Care Utilization Data

Utilization data obtained from the Vanderbilt information systems usage logs showed that accesses to the POC occurred as shown in Table 14.

The vast majority of POC access, based on system utilization logs, was from the CCs (nearly 80 percent), followed by MAs and the MHT development team leader. Providers were noticeably missing from this data, and RNs and social workers had negligible use, consistent with interview findings that accessing the POC is not part of their routine. These findings suggest that some members of the care team could make better use of the POC tools to support communication and information sharing.

Table 14. Utilization Data: User Access to Plan of Care over 14 months**

Role	Page Views: Count	Page Views: %
Care Coordinator (CC)	480,159	76
Medical Assistant (MA)	81,463	12
MHT Development Team Lead	45,801	7
Other*	22,847	3
Total	630,270	100

*Other includes IT staff, social workers, and users at non-study sites. **7/17/13 to 9/17/2014

Section 4. Discussion and Conclusion

Health IT Impact on Workflow

Multiple work activities, roles, and technologies interacted in this real-world environment of six primary care practices introducing (or having introduced) care coordination redesign. With many different IT components functioning individually and together to enable and support various workflows, the overall impact of health IT on workflow was mixed. The impact was best understood by examining seven broad areas of work and a variety of technologies in routine use by the care coordinator, clinical teams, and patients.

Cultural, physical, policy, and social environments were observed to play an important role in many of the health IT – workflow interactions we observed, and factors in one part of the work system often affected other parts. For example, having (or not having) physical co-location between clinicians and CCs affected the use of communication tools, which played a more significant role when CCs were remote. Team culture shifted more slowly or quickly depending on physical co-location and team expectations as well. Some team members reported not being sure whether the CCs would be permanent or transient. A CC reported sharing a list of all of her current and potential tasks and activities with team providers from time to time, hoping to improve team understanding of her role. With more time and contact to strengthen new team relationships, CCs reported that cultural barriers seemed to soften, allowing for better integration of the CCs with the team.

Through interviews, observations, utilization data, and analysis focused on the CC work activities, our research team created a crosswalk or matrix of workflows and IT features used to produce or support a work activity, allowing a rich understanding of the impact of health IT on workflow to emerge.

Use of the POC

Focusing narrowly on the CC, the POC was found to be a useful tool, with some limitations. CCs found it useful as an action-oriented tool (a plan), useful for actions produced from background information searching, discussions with patients, and clinical decisionmaking. However, CCs also found it somewhat limiting for certain kinds of documentation, and reported needing more space to document actions and plans, such as sharing the available information and reasoning for a medication dose change decision. The following discussion considers how the impact of the POC might be increased.

Sharing the POC among the care team could positively impact communication, information awareness, situational awareness, and information timeliness. POC alignment with the broader care team was not as strong as with the CC. In general, the work of team communication, information awareness, situational awareness, and information timeliness was more varied and complex than the work of the CC, which *was* supported by the POC.

The POC was originally envisioned to be used by a wide range of individuals including primary care providers, specialists, clinic nurses, care coordinators, and others involved in providing care for patients enrolled in MHTAV. It is not clear why, especially in light of the usage data, this is not currently the case. More exploration is needed to understand how the POC could better serve the communication and coordination activities for multiple team members in addition to the CCs. More research would also help to identify the communication needs and constraints in clinical settings, and the practice norms that should be supported.

The development and implementation of health IT tools can serve as a catalyst for the development of clinical policies and related practice expectations and workflows.[23] For example, hypertension and diabetes are common comorbidities and are also frequently treated by primary care providers and by diabetes specialists. The process of developing and implementing a POC for these patients can reveal the available content (or lack) and institutional consensus among primary care, cardiology, and endocrinology providers for disease management. In this way, the MHT software could have a greater impact on team performance by doing more to help the team understand what the CCs do and how other team members could help them. In other words, if the MHT system created more transparency for other team members concerning the CCs' role, documentation work, and other activities related to patients' POCs, care coordination work as a weakly embedded routine[24] might change.

Monitoring and reporting POC use might help to identify workflow gains or challenges across the care team, strengthening impact. Since health IT can serve a dual role, supporting the work activities of care coordination and monitoring the activities to improve performance, it should be assessed in both contexts. In the context of this study, monitoring of system use was not routinely used by or made available to managers, clinical staff, or CCs. In addition to meeting developers' needs for feedback on system design, understanding who (that is, individuals in specific roles) is accessing the POC could facilitate identification of emerging best practices in coordination and efficient clinical decisionmaking.

Broadening the focus of the POC to additional conditions beyond hypertension, diabetes, and heart failure will impact more patients and providers. Expanding the focus of the POC to additional disease conditions would expand not only the number of patients eligible to participate in the care coordination program, but the number and diversity of providers from various specialties, as well as support staff. This kind of expansion to greater scale can be challenging for systems designed with a narrower focus. As use of the POC advances, it will need much greater flexibility to accommodate the care of complex patients.

Communication

Observations and interviews with CCs and clinical staff identified spatial proximity—the close physical co-location of CCs with other care team members—as a factor in their use of e-messaging applications for communication: greater e-messaging was associated with separate locations.

This finding suggests that health IT has different impact on the types of communication occurring among participants who are physically co-located versus frequently separated, and raises questions about how best to support their workflow. Clinical team members, patients, and CCs have many small windows of time to meet with patients, confer with one another, and make decisions. Asynchronous communications such as e-mail can be more convenient when communications are not urgent, whereas direct SMS can help when an immediate response is important. There are many unanswered questions about how to best use IT for sensitive communications, such as a provider colleague who did not manage a patient appropriately, or a patient suspected to be a victim of child abuse.

Also, since team activities such as the initial enrollment of patients in MHTAV, and the cultural integration of the CC role into the clinical team, were observed to vary over time, more research is needed to understand how, when, and with what tools, the CCs can best engage with patients and with clinicians using different forms of IT-supported communication.

Search

In working with patients and other care team members, CCs constantly used tools to search for information about patients, their care, and the care team. They searched for clinical data such as a recent blood pressure reading, administrative data such as a phone number or name of a caregiver, care activities such as when the next blood test was due, care goals, such as what the target weight should be, and event information such as the last hospital admission.

Overall, the searching and sensemaking process was not seamlessly supported by health IT – there was much room for improvement. Improving tools for search is an important area for further research because information that is valuable or critical for decisionmaking requires time, machine resources, and cognitive resources to obtain and process. New data science methods are advancing the identification of potentially meaningful patterns in data and production of alerts for human factors, especially important in health care where available human resources are especially limited.

MHTAV Program Adoption

Levels of care team understanding of the CC role and integration of the CCs work into team activities varied over time and between the MHTAV and MHTAV-adopting site teams. These variations help to explain the varied impact of similar health IT across different site teams.

While the MHT system (including the POC and disease control forms) directly supported the CCs' work, the design of the MHT tools perpetuated care coordination work as a *weakly embedded organizational routine*.[24] In other words, the design and implementation of the program and related tools did little to integrate the work of the CC with existing activities central to the clinic's operations. For example, instead of scheduling their work (such as calibration of a glucose monitor) as a part of the patient visit, CCs developed their own strategies to identify when patients they needed to see were in the clinic and "catch" them. The design of the tools also did not facilitate shared awareness with other team members; the tool did not help the team understand what CCs were doing and how they could help.

High-performing, cohesive teams are desirable in health settings,[25] and require time and discipline to overcome normal team challenges such as establishing trust, having clear accountabilities, tolerating productive disagreements, having confidence in a shared commitment, and paying attention to results.[26] Observations in this study showed that team dynamics shifted when CCs were introduced to the team(s). For example, extant clinical teams (nurses, NPs/physicians) needed time, exposure to CCs, and an understanding of the CC's role and capabilities before they could appreciate how the CCs could best function on the team. Some CCs had to promote their abilities and capabilities to other team members. Time was also needed to develop trust and interaction among team members. CCs varied in their degree-of-presence, and the overall MHTAV program, which began as a pilot and then expanded, was unfamiliar to most clinicians at first and not clearly understood to be permanent by some team members.

If team integration around redesigned work processes during adoption of the MHTAV program were a greater focus this could create transparency of the CC role for others on the team. For example, perhaps "recent actions with the patient" could have highlighted CC activity on the main EHR screen to make CCs' actions supporting patient care more visible. Even a picture of the CC who was doing the work might have helped to create more awareness, especially for CCs who worked remotely from the care team. If the focus of program adoption was broadened to adapt each clinical role as suggested in some models,[27] additional changes in health IT would be needed.

Shifts in the Impact of Health IT and Workflows

Judgments about the alignment and impact of health IT on workflow shifted dynamically as individuals adapted their work activities, their use of the software systems and other tools, and their interactions with the care team and patients. The findings in this report present a snapshot of the alignment observed at specific times. For example, some assessments performed early in the MHTAV implementation in MHTAV-adopting practices sometimes captured statements criticizing the system, which might have been affected by the stress that can occur during and after initial "go live."

Research staff also observed that alignment worsened over time in some cases, such as when auto-enrollment expanded the number of patients in the care coordination program but diminished the relationship-building opportunity that CCs had with patients when they were initially contacted in person. In other cases, such as the accumulation of reliable patient education resources (including the Krames system and other Internet-based resources), alignment strengthened over time. As the CCs became more confident in their role and shared resources they found with one another, their collection of print and Internet resources grew and became more useful.

Care Coordination Work Over Time

Overall, changes over time were observed, but were inconsistent due to a number of contextual factors. In task-oriented areas such as "Search for Information" and "Establishing and Maintaining a Plan of Care," and also in work areas specific to the CC such as "Prioritizing and Planning Work," changes over time were related to adapting the work and the technology to one another. For example, we observed that CCs developed new strategies to rapidly document the evidence for an "action" in the POC. In areas involving more interaction among clinic staff and CCs such as "Coordination with Other Clinicians," changes over time differed between established MHTAV clinics and newly-implemented teams. In site teams new to MHTAV, implementation involved establishing templates for both clinical and technological coordination, whereas established MHTAV site teams had already developed these.

An example of a clinical coordination template is when clinic nurses learn the CC's clinical scope of responsibility and include her on relevant messages and other documentation, such as when a diabetes patient has a question about changing a medication dose. An example of a technological coordination template is when CC develops informal messaging protocols and a physician agrees on specific headers for messages about MHTAV patients. Much work is required for newly implemented clinics to develop these templates, including developing social relationships among staff, clinic staff learning the skills of the CC, understanding when the CC should be engaged, and building trust among team members. A clinic that had already implemented MHTAV with several physicians experienced a much smoother process bringing a new physician into the MHTAV program, because the relationships were already established among the staff and the coordination templates already existed. In the language of distributed cognition,[28] the *clinic* already knew how to enact the MHTAV program and could leverage improvements in communicating, setting expectations, and planning over time to support care coordination work.

The overall care coordination work system we studied was complex and dynamic. Its complexity arose from the many individuals, tasks, tools, and interactions that take place daily or hourly. Almost constant adaptation occurred as CCs and care team members responded to challenges that arose with new patients, changes in staffing and team workflow, and team

interactions. The sense of change over time was also impacted by prior work patterns that were often not replaced, but rather, complemented, with redesigned care coordination activities.

Lessons Learned

This study identified the multiple activities, workflows, and systems supporting five primary care coordination work activities and two supporting activities, and a range of alignment between the IT and the workflows. The underlying drivers of good, neutral, or poor alignment seemed to vary. Many factors impacted alignment, such as gaps in system design (for example, limited IVR tailoring) suggesting missing features or incomplete features; variations in CC communication activities (in-person communication versus remote asynchronous communication between CC and care team members); and barriers to information sharing (limited use of the POC by the care team).

We found that poor alignment was common, reflected underlying issues, and required varying solutions alone or in combination, such as context-specific changes in workflow, IT, training, communication, and information transparency. The fact that care coordination (as viewed by the CC in this study) was a broad set of activities involving many different tools and systems, performed alone or with many others, added to the complexity of assessing alignment between IT and workflow and determining how to improve it.

System use logs that were not examined previously by care coordination program leaders showed few accesses to information in the POC by care team members, which program leaders were surprised to see. This finding supports the AHRQ Report on Electronic Health Record Usability, which recommended "improving the ability to track and evaluate actual EHR use through expanded use of audit trails and structured analysis of navigation patterns…."[29] Health IT system developers should consider enabling access to analytic tools that can assist health care organizations in assessing workflow, coordination, efficiency, and other key aspects of work practices.

Another important lesson learned was the creativity and flexibility CCs demonstrated as they faced the challenging tasks of care coordination. As CCs developed ways to communicate with patients and teammates, find patient information, and use the available system tools more effectively, they adjusted their workflow and solved problems in a flexible way. Software tools that offer more flexibility would be even more helpful with the CC's work as it changed. Just as software tools need to evolve over time, training needs also continue long after the "break-in" period when new health IT is first introduced, since work activities adapt over time.

We did not formally assess team performance in this study, but would recommend doing so in future studies of care coordination given the importance of its role in primary care settings and in care coordination specifically.

Since the overall study focused on use of health IT, POC utilization data and the TAM survey were obtained to add context to the qualitative findings. The POC data raised a useful question for program leaders: *should providers also be accessing the POC?* The utilization data collected for this research project were not available to program leaders or site teams, but could be of interest if it helped to identify differences across different teams. The TAM survey data helps to provide some context about attitudes toward technology among study participants, especially if comparing them with other studies where the TAM was used. However, the TAM survey results did not add useful detail relative to the interview and observational data already collected. The PAM and SDSCA results obtained from patients did not inform the main study

findings because they focused on patient self-care activities that are connected to care coordination, but are separate from the interactions between health IT and workflow studied. Similarly, data showing patient disease outcomes such as HbA1c and LDL for diabetes did not help to address the research question.

The SEIPS and WEM frameworks helped to organize the collection of data and subsequently describe work activities as they were performed in technological, spatial, temporal and political contexts. Systematically identifying and labeling these contexts helped to identify more generic challenges and features of the task. For example, the traditional clinical care task of documentation can contribute to (or impede) an appropriate level of information detail, machine-level information capture (which later supports search functionality), and communication among care team members (patients, caregivers, specialists, clinic nurses, and primary care providers). Using the frameworks helped to prompt investigators to identify and satisfy each element in the framework during data collection. This can help to connect specific observed details with more generalized workflows.

Technology matrices were conceptualized by the research team as a new way to analyze and present alignment of workflow with IT resources and features. The initial goal was to provide a numerical assessment of the fit as a score. However, the data did not support use of a single summary score to represent these relationships because each matrix actually includes multiple activities, workflows, and supporting technologies. Instead, "scoring" each interaction rather than the overall matrix made sense. The language of *good, neutral, and poor alignment* was used to describe how well a technology feature supported a task, while recognizing that the strength of alignment did not necessarily reflect the value of the task itself. That is, alignment could be very strong or weak *independent of* the usefulness of the task.

Conclusion

This qualitative study of care coordination and health IT-enabled redesign in Tennessee used rigorous qualitative methods to assess the impact between health IT and workflow in six primary care practices during the implementation of a care coordination program for several chronic conditions including hypertension and diabetes. Data obtained through interviews and direct observation, supplemented with system utilization logs and staff and patient surveys, were analyzed using qualitative methods based on the SEIPS and WEM frameworks. Five areas of primary work and two areas of supporting work were identified from analysis of field notes, along with the technologies used to support them. In each area, a workflow diagram and a technology matrix were produced to describe the work, the IT, and the interaction between them.

Analysis of care coordination involving multiple providers, coordinators, patients, caregivers, and care team members revealed a complex picture with multiple workflows and varied IT systems used alone and in combination to support those workflows. This analysis viewed the role of the care coordinator (CC) as a primary focus, and considered providers and other team member work in relation to the work of the CC, since the CC role served as the centerpiece of the MHTAV program.

Overall, the impact of health IT on workflow was mixed, ranging from good, to neutral, to poor depending on the specific areas being examined. Our findings support the WEM assertion that context, aggregation, and temporality can impact the alignment of health IT and workflow. The opportunities for improved impact varied from changing the system design, to adding missing features, to reducing work activity variation (or supporting the variation), to improving the user interface. Stronger impact was noted when there was a well-defined workflow, 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 learning to take place. The MHTAV program was primarily focused around the CC role, but failed to adequately address other actors within the work system (clinic nurses and providers). For example, the health IT that was developed for the program (i.e., the MHT software) was only accessible to CCs, which limited its ability to support team-based care. Enabling access to other members of the patient care team, such as via nurse and provider portals, could potentially have provided more contextual information, insight into the CC's actions, opportunities to assist with tasks better suited to a provider, and a stronger sense of team collaboration.

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 fairly uniform IT environment, its impact can vary substantially with variations in the physical, social, and policy environment, and as the implementation of care coordination shifts from a narrow scope (the new CC role and a few conditions) to a much broader one. Further research to improve the impact of health IT on care coordination activities is important to technology designers, program leadership, and those who perform the daily activities of care coordination.

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Appendix A: My Health Team Collaborative Care Management Protocol

Hypertension

Table 1. Stratification of Patients with Hypertension

Level 1—Low-Risk Category: HTN-only patients, default for pts not in Level 2 or 3.
Level 2—Moderate-Risk Category: CKD stage 3 or greater and/or more than 3 medications. Comorbid diabetes and/or heart failure with symptoms well controlled. DM: blood sugar without extreme highs (above 180) and/or lows (below 70) and/or NHYA Classification I or II.
Level 3—High-Risk Category: Comorbid diabetes with retinopathy, neuropathy, hypoglycemic unawareness, and/or short term episodes of extreme highs (above 180) and lows (below 70) with blood sugar, unhealed wounds and /or heart failure with dyspnea upon exertion, oxygen dependence, and/or unstable weight. NYHA Classification III or IV. Admission or ED visit for related issue in past 6 months; frail, elderly; clinical gestalt

CKD = chronic kidney disease; DM = diabetes mellitus; ED = emergency department; HTN = hypertension; NHYA = New York Heart Association; pts = patients.

Table 2. Care Coordination Process Protocol for Patients with Hypertension

Risk Stratification and Status	At Control	Chronic Assessment by Physician	Frequency of Patient Self-Monitoring	Frequency of CC/MA Contact
Initial verification of physiologic control: **1A/2A/3A**	Patients < 80 years old: **BP:** <140/90 mmHg Patients ≥ 80 years old: **BP:** <150/90 mmHg		**1A/2A/3A:** Increase frequency of physician or provider encounter if blood pressure is 180/110 or above.	
Surveillance of physiologic control: **1A/2A/3A**	Patients < 80 years old: **BP:** <140/90 mmHg Patients ≥ 80 years old: **BP:** <150/90 mmHg Patients with comorbid diabetes: BP: ≤140/80 mmHg	**1A:** Annual physician encounter **2A:** Every 6 months or yearly per physician **3A:** Every 3 months	**1A/2A:** No requirements unless requested by physician noting additional concern for HTN. **3A:** Home BP measurement once daily (minimum sample of am and pm values, BID if possible. Evaluate average last 6 readings to determine if patient at goal or control. **1A/2A/3A:** Increase frequency of physician or provider encounter if blood pressure is 180/110 or above.	**1A/2A:** Evaluation of control based on surveillance by MHTAV tool. **3A:** CC Every 4 weeks: adjust per CC or Physician discretion; goal is to obtain sample of am and pm readings.
Titration: **1B/2B/3B**	Patients < 80 years old: **BP:** <140/90 mmHg Patients > 80 years old: **BP:** <150/90 mmHg Patients with comorbid diabetes: **BP:** ≤140/80	Every 4 weeks for systolic 150-179 Every 2 weeks for systolic ≥ 180	Home BP measurement BID until control achieved; Evaluate last 6 BP readings to determine if patient at target. Patient time to collect/submit home BP readings varies based upon certain drugs, age, or frailty as correlated to CC frequency. **1A/2A/3A:** Increase frequency of physician or provider encounters to every 2 weeks if blood pressure is 180/110 or above.	• CC-Q 3-4 weeks. • Patients needing slow titration may need up to 4-5 weeks between anti-hypertensive changes.

[1] BID = twice a day; BP = blood pressure; CC/MA = care coordinator/medical assistant; HTN = hypertension; MHTAV= My Health at Vanderbilt.

Diabetes

Table 3. Stratification of Patients with Diabetes

Level 1—Low-Risk category • Hemoglobin A1C <8 and • Patient on < 3 meds, no more than simple insulin regimen (long-acting, only) • No nephropathy, retinopathy or neuropathy or mild stable complications • Stable mild complications (Stage 1 or 2 nephropathy or change within stage) followed by a subspecialist (cardiology, nephrology, neurology, ophthalmology) • No history of frequent hypoglycemia, blood sugar below 70, (less than 2-3 per month) • No hypoglycemia unawareness • No severe hypoglycemia (syncope and seizure with cognitive deficits)
Level 2—Moderate-Risk Category • Hemoglobin A1c < 8%, and • Use of complex insulin regimen (more than 1 dose of insulin per day or pump) including intensive insulin therapy, mixed insulin therapy and insulin pump • Contemplating pregnancy
Level 3—High-Risk Category: • Hemoglobin A1c ≥ 8%, or • Use of complex insulin regimen (more than 1 dose of insulin per day or pump) including intensive insulin therapy, mixed insulin therapy and insulin pump • Significant renal disease (Stage 3 or 4 nephropathy), visual impairment, hx of falls or foot ulcers • Hypoglycemic unawareness • Frequent hypoglycemia, blood sugar below 70, more than 2-3 times a month • Frail, elderly or otherwise with comorbidities • ED visit related to diabetes in the last 6 months • Hospitalization related to diabetes in the last 6 months • Pregnant patients

Table 4. Care Coordination Process Protocol for Patients with Diabetes

Risk Stratification and Status	At Control	Chronic Assessment by Physician	Frequency of Patient Self-Monitoring	Frequency of CC/MA Contact
Initial Verification of Control: **1A/2A/3A**	Patients < 80 years old: A1C <7.0 *OR* Patients >80 years old: A1C < 8.0 *OR* MD Specification	At least once a year		**1A:** 6 months-yearly between scheduled appointments with provider **2A:** Every 6 months between scheduled appointments with provider **3A:** Every 6 months between scheduled appointments with provider
Surveillance of Control: **1A/2A/3A**	Patients < 80 years old: A1C <7.0 *OR* Patients >80 years old: A1C ≤ 8.0 *OR* MD Specification	**1A:** Annual office encounter **2A:** Every 6 months **3A:** Every 6 months	**1A:** A1C reading every 6 months with PCP approval **2A/3A:** A1C every 3 months	Every 6 months between scheduled appointments with provider
Titration: **1B/2B/3B**	Patients < 80 years old: A1C ≥ 7.0 *OR* Patients > 80 years old: A1C ≥ 8.0 *OR* MD Specification	Every 3 months	*When adding a medication, wait 1 week and report any lows <70 or side effects.* *Check 3-4 days of blood glucose measurements:* *A1C > 9: premeal, postmeal and bed time* *A1C ≤ 8: 2x's a day (some fasting, some after meals (different meals and different days)* *Send range and average blood glucose.* **3B:** Per PCP or Specialist Directive-Frequency per day/wk, time of day Evaluate average, low and high range	Every 3-4 weeks or adjusted by provider

A1C = glycated hemoglobin test; CC/MA = care coordinator/medical assistant; PCP = primary care provider.

Form Approved
OMB No. 0935-0208
Exp. Date 03/31/2016

Appendix B: Staff Interview Guide

Using Health Information Technology in Practice Redesign: Impact of Health Information Technology on Workflow

Staff Interview Guide

Public reporting burden for this collection of information is estimated to average 60 minutes per response, the estimated time required to complete the survey. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: AHRQ Reports Clearance Officer Attention: PRA, Paperwork Reduction Project (0935-0208) AHRQ, 540 Gaither Road, Room # 5036, Rockville, MD 20850.

Thank you for participating in the study today. The goal of the study is to learn about your work related to care coordination, including the computer-based tools you interact with to do that work. There are two parts to the study. The first is an interview where we will ask you questions to learn about your work related to care coordination, including the computer-based tools you interact with to do that work. After you complete the interview, we will ask you to fill out a short survey about you use technology in your work. First we need to review the consent documents.

[Give subject copy of consent form and review elements of consent].

Please read the form carefully. If you still would like to participate in the interview, please sign the consent form. If you agree to have the interview recorded, please initial the line next to the first statement. If you do not agree to have the interview recorded, please initial the line next to the second statement. Do you have any questions before we move on?

[After respondent agrees to participate and signs consent form]

Thank you again for agreeing to participate in the study today. As I mentioned before, the goal of the study is to help us learn about your work related to care coordination, including the computer-based tools you interact with to do that work.

- *If subject has agreed to audio recording:*
  I have set up the tape recorder here in front of us. Please speak clearly during the interview so that the tape will record your voice accurately. I may ask you to repeat a response to make sure that it is recorded.

- *If subject has not agreed to audio recording and a note taker is not available:*
  I will take notes during our conversation today. I may ask you to slow down or pause for a moment so that I can record what you say accurately.

- *If subject has not agreed to audio recording and a note taker is available:*
  My colleague [NAME] will take notes during our conversation today. He/she may ask you to slow down or pause for a moment so that he/she can record what you say accurately.

During the interview, please use only your first name if you refer to yourself. This will help us keep your responses private. Your individual answers will not be reported to your fellow care team members or the clinic management. If we do share information from the interview, we will only report it at the aggregate level, so that it is not obvious who said what.

The interview will take about one hour to complete. If you need to take a break during the interview to use the restroom or get a drink, please let me know and we will pause the interview.

If any of my questions aren't clear or you don't understand a word that I use, please let me know and I will rephrase the question for you.

Please remember that you are not required to answer any specific question. You may also leave the interview at any time.

At the end of the interview, we will ask you to fill out a short survey about how you use technology in your work. Once you have completed the interview and the survey, you will receive a gift of $25 for your participation.

Do you have any questions before we start the interview?

A. Clinic Name: [*Record Clinic Name*]:

B. Demographic Information

We are going to start by asking you some general questions about yourself. For some of these questions, I will read off choices for you to choose from.

1. What is your age?

   - ☐ 25 or under
   - ☐ 26-35
   - ☐ 36-45
   - ☐ 46-55
   - ☐ 56-65
   - ☐ 65 or older

2. What is your gender? _____

3. Are you Hispanic or Latino/Latina? No/Yes

4. For this question, I will read off several choices. What is your race? Please select one or more.

   - ☐ American Indian or Alaska Native
   - ☐ Asian

- ☐ Native Hawaiian or other Pacific Islander
- ☐ Black or African American
- ☐ White

5. Please describe your educational background, what degrees you have and where you trained, and any additional types of training you have.

6. What is your current role at the clinic?

7. How many years have you been doing this job?

8. Can you give a brief overview of your prior experience?

C. Technology Experience in General

We will now move to some questions about your experience with technology in health care settings.

1. What electronic health record (EHR) programs/systems have you used in the past or are you presently using?

2. How long have you used these systems? Or for systems used in the past, how long did you use them?

3. How would you describe your level of proficiency with these systems/programs?

4. How quickly or easily do you learn new computer programs/systems?

D. Work Routines

Now we are going to turn to the topic of work routines. The next few questions will ask about your work routines and how you care for patients with diabetes.

All Clinics:

1. Can you describe your daily work routine?

2. Please describe your routine interactions with patients.

3. Can you walk us through some daily activities involving the coordination of care for patients with diabetes?

Early-MHT Clinics:

1. How have your routines related to care coordination for diabetes patients changed since before the MHT implementation?

2. Has the implementation of the MHT system changed your work experience? If so, how?

E. Interaction with Computer Technology/Work Context

Pre-MHT:

1. How much time in a typical day do you spend using health IT? During work? Before or after work hours?

2. How does technology affect the pace of your daily work routines?

3. Does technology "consume" or "save" time in your daily schedule? How does it "consume" or "save" you time?

4. What is your comfort level with using the computer systems and/or programs that you use on a daily basis?

5. What processes do you use to coordinate the care of patients that involve using technology?

Early and Mature MHT Clinics:

1. Has the amount of time that you spend using technology during your work day changed since the implementation of MHT? In what ways?

2. What processes do you use to coordinate the care of patients using technology?

3. What is your comfort level with the MHT system?

4. How do you feel about care coordination after the MHT implementation?

F. Strategies for Dealing with Unanticipated Workflow or Health IT Challenges

Now I am going to ask you some questions about how you deal with challenges associated with caring for patients, either because of current workflows or due to technology.

Pre-MHT Clinics:

1. How do you accomplish coordination of patient care right now for patients with diabetes?

2. What challenges do you face in performing care coordination activities for each patient?

3. When problems arise with coordination of care, how you deal with them?

4. How do you improvise to deal with technology or organizational issues that impact coordination of care?

Early and Mature MHT Clinics:

1. How do you accomplish coordination of patient care *right now* for patients with diabetes (if appropriate: *since implementing the MHT system*)?

2. What challenges do you face in performing care coordination activities for each patient?

3. When problems arise with coordination of care, how do you deal with them?

4. What are your impressions of the coordination of patient care after the MHT implementation?

5. What challenges do you face in your work routines after the MHT implementation?

6. What issues have you experienced in using the MHT system?

7. What strategies do you use to deal with these issues?

G. Conclusion

That concludes our interview. Thank you very much for your participation today! I will now give you the survey to complete. If you have any questions about the survey, please feel free to ask me. Thank you again for your time and participation.

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OMB No. 0935-0208
Exp. Date 03/31/2016

Appendix C: Patient Interview Guide

Using Health Information Technology in Practice Redesign: Impact of Health Information Technology on Workflow

Patient Interview Guide

Public reporting burden for this collection of information is estimated to average 60 minutes per response, the estimated time required to complete the survey. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: AHRQ Reports Clearance Officer Attention: PRA, Paperwork Reduction Project (0935-0208) AHRQ, 540 Gaither Road, Room # 5036, Rockville, MD 20850.

Thank you for participating in the study today. The goal of the study is to learn more about how your health care providers work with computers and with each other. There are two parts to the study. The first is an interview where we will ask you questions about yourself, your health history, and your care experience here at the clinic. The second part includes filling out two short surveys. After you complete the interview, we will ask you to fill out two short surveys about your diabetes and your health. First we need to review the consent documents.

[Give subject copy of consent form and review elements of consent].

Please read the form carefully. If you still would like to participate in the interview, please sign the consent form. If you agree to have the interview recorded, please initial the line next to the first statement. If you do not agree to have the interview recorded, please initial the line next to the second statement. Do you have any questions before we move on?

[After respondent agrees to participate and signs consent form]

Thank you again for agreeing to participate in the study today. As I mentioned before, the goal of the study is to help us understand how your health care providers work with computers and with each other.

- *If subject has agreed to audio recording:*
  I have set up the tape recorder here in front of us. Please speak clearly during the interview so that the tape will record your voice accurately. I may ask you to repeat a response to make sure that it is recorded.

- *If subject has not agreed to audio recording and a note taker is not available:*
  I will take notes during our conversation today. I may ask you to slow down or pause for a moment so that I can record what you say accurately.

- *If subject has not agreed to audio recording and a note taker is available:*
  My colleague [NAME] will take notes during our conversation today. He/she may ask you to slow down or pause for a moment so that he/she can record what you say accurately.

During the interview, please use only your first name if you refer to yourself. This will help us keep your responses private. Your answers will not be individually reported to your care team members here at the clinic. If we do share information from the interview with clinic staff, we will only report it at the aggregate level, so that it is not obvious who said what.

The interview will take about one hour to complete. If you need to take a break during the interview to use the restroom or get a drink, please let me know and we will pause the interview.

If any of my questions aren't clear or you don't understand a word that I use, please let me know and I will rephrase the question for you.

Please remember that you are not required to answer any specific question. You may also leave the interview at any time.

At the end of the interview, we will ask you to fill out two short surveys about your diabetes and your health. Once you have completed the interview and the surveys, you will receive a gift of $25 as a thank you for your participation.

Do you have any questions before we start the interview?

A. Clinic this patient uses: [*Record Clinic Name*]

B. Demographic information:

We are going to start by asking you some general questions about yourself. For some of these questions, I will read off choices for you to choose from.

1. What is your age?

   ☐ 25 or under
   ☐ 26-35
   ☐ 36-45
   ☐ 46-55
   ☐ 56-65
   ☐ 65 or older

2. What is your gender? _____

3. Are you Hispanic or Latino/Latina? No/Yes

4. For this question, I will read off several choices. What is your race? Please select one or more.

   ☐ American Indian or Alaska Native
   ☐ Asian

- ☐ Native Hawaiian or other Pacific Islander
- ☐ Black or African American
- ☐ White

5. Please describe your education.

6. Please briefly describe your work experience (past, current)

For the next three questions, I will read off choices after I ask the question.

7. What is your household income?

   - ☐ Under $10,000
   - ☐ $10,001 – $24,999
   - ☐ $25,000 – $39,999
   - ☐ $40,000 - $49,999
   - ☐ $50,000 - $74,999
   - ☐ $75,000 - $99,999
   - ☐ Over $100,000

8. What is your marital status?
   - ☐ Single
   - ☐ Married
   - ☐ Divorced
   - ☐ Separated
   - ☐ Widowed
   - ☐ Partnered

9. What type of health insurance do you have?
   - ☐ Private insurance (e.g., provided through your employer or school)
   - ☐ Medicare (*provided to citizens over the age of 65 or with certain medical conditions*)
   - ☐ Medicaid (*provided to low income individuals, most often women and children*)
   - ☐ Military insurance (e.g., Tricare)
   - ☐ Uninsured
   - ☐ Other
   - ☐ Not sure

C. Health History

We are now going to ask you some questions about your health history and your care experience, such as how often you come to the clinic, who you talk to while you are here, and how you and your doctors work together to manage your health and your care.

1. Please describe the diagnoses received from a doctor and the approximate dates of diagnosis.

2. How would you describe your health?

   Probe for specific information (e.g., ask whether their glucose levels have been high or low).

D. General Care Experience

1. How often do you come to this clinic for your diabetes?
2. Who do you talk to or see about your diabetes?
3. Please discuss your experience with this clinic: things that go well, and things that don't go well.

   Probe for issues that are relevant to care coordination for their diabetes, and any observations or experiences concerning the role of health IT.

E. Patient Workflow

Now I am going to ask you some questions about the tasks you do to manage your health.

1. Describe what you do at home (and other places outside the clinic) to take care of your diabetes.

2. Please describe the typical process for visiting the clinic, including activities before and after the actual visit.

   Use paper artifacts if necessary.

3. Describe phone calls or visits you usually have in between appointments, such as blood work, at the clinic.

4. Do any of the staff from this clinic talk to staff in other clinics (e.g., your endocrinologist) about you and your health conditions (e.g., to make appointments for you, or to get or give information)? If so, please describe.

F. Problems Related to Your Diabetes Care

Now I am going to ask you some questions about challenges that you may have encountered in receiving care for your diabetes.

1. What are some of the problems or challenges you've encountered in receiving health care for diabetes?

2. Describe any problems or challenges you've had with the clinic, getting information or sharing information about your care for diabetes.

G. Strategies for Managing Diabetes-Related Information

In this section, I will ask you about how you manage information related to diabetes.

1. Regarding your diabetes, what information do you need to manage?
   (*Offer examples if necessary: your list of medicines and when you take them; your blood sugars; your routines such as exercising, eating, and glucose testing; your future office visits, future lab visits, and medication refills or renewals; reminders for any/all of these things*)

2. How do you manage the information related to your diabetes?
   Include each area outlined in previous question.

3. How do you let your doctor or your doctor's staff know how you are doing at each appointment?

4. How do you let your doctor or your doctor's staff know how you are doing in between appointments?

H. Overall Assessment

This is the last question in the interview.

1. Please give us your impression of the way the clinic coordinates your diabetes care.
   Ask about general and clinic-specific programs (e.g., followup calls and patient portal).

I. Conclusion

Thank you very much for your participation today! I will now give you the two surveys to complete. If you have any questions about the surveys, please feel free to ask me. Thank you again for your time and participation.

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Exp. Date 03/31/2016

Appendix D: Technology Acceptance Model Survey

Using Health Information Technology in Practice Redesign: Impact of Health Information Technology on Workflow

Technology Acceptance Model Survey

Public reporting burden for this collection of information is estimated to average 30 minutes per response, the estimated time required to complete the survey. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: AHRQ Reports Clearance Officer Attention: PRA, Paperwork Reduction Project (0935-0208) AHRQ, 540 Gaither Road, Room # 5036, Rockville, MD 20850.

INSTRUCTIONS

Thank you for your cooperation in completing this survey. This questionnaire has been designed to gather information about your perceptions of StarPanel and coordinating care. StarPanel refers to Vanderbilt's web-based application for medical record information and communication, including functions such as electronic messaging with patients and other providers, e-prescribing, outpatient order entry, and provider documentation. Coordinating care refers to integrating care across all elements of the health care system including primary and specialty care, hospitals, and home health care.

When completing it, you should think about how you feel and what you think, based on your experiences. Some questions may sound similar to others, but please still try to answer all of the questions. You can leave blank any questions that you do not want to answer. If you don't know an answer to a question, please just mark the response for "Don't know." Remember that your responses are strictly confidential and will be closely guarded. Nobody at your facility will ever see your individual responses.

To answer the questions, circle the appropriate response on the scale. For example:

	Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
To what extent are you satisfied with StarPanel?	0	1	2	3	4	(5)	6	❑

We appreciate the time you are taking to complete this questionnaire and hope that the information will help us better understand technology and care coordination.

Thank you for your cooperation!

*The following set of questions asks about your perceptions of **StarPanel**.*
*Please respond thinking about **your own** experiences.*

***Think about** the last 2 weeks…*		**Not at all**	**A little**	**Some**	**A moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**	**Don't know**
1.	To what extent are you satisfied with using StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
2.									
3.	To what extent are you dissatisfied with using StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
4.	To what extent would you recommend StarPanel to a colleague at another clinic?	0	1	2	3	4	5	6	❑

***Think about** the next 3 months…*		**Not at all**	**A little**	**Some**	**A moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**	**Don't know**
5.	Over the next 3 months, to what extent do you intend to use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
6.	Over the next 3 months, to what extent do you predict that you will use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
7.	How much do you want to use StarPanel to coordinate care over the next 3 months?	0	1	2	3	4	5	6	❑

	***Think about** the last 2 weeks…*	**Not at all**	**A little**	**Some**	**A moderate amount**	**Pretty much**	**Quite a lot**	**A great deal**	**Don't know**
8.	How much has using StarPanel to coordinate care improved patient care?	0	1	2	3	4	5	6	❑
9.	How much has using StarPanel to coordinate care made caring for patients easier?	0	1	2	3	4	5	6	❑
10.	How much has using StarPanel to coordinate care reduced the likelihood of errors in care?	0	1	2	3	4	5	6	❑
11.	How much has using StarPanel to coordinate care improved your ability to collaborate with others involved in patient care?	0	1	2	3	4	5	6	❑
12.	How much has using StarPanel to coordinate care given you new insight into your patients' health?	0	1	2	3	4	5	6	❑
13.	How much has using StarPanel improved your ability to communicate with patients to coordinate their care?	0	1	2	3	4	5	6	❑
14.	How much has using StarPanel improved how well you can communicate with others in your clinic to coordinate patients' care?	0	1	2	3	4	5	6	❑
15.	How much has using StarPanel improved your ability to communicate with others outside your clinic to coordinate patients' care?	0	1	2	3	4	5	6	❑
16.	How much has using StarPanel to coordinate care improved your ability to keep patients on track?	0	1	2	3	4	5	6	❑
17.	To what extent does using StarPanel improve your ability to coordinate health services with patients to get them the care they need?	0	1	2	3	4	5	6	❑
18.	To what extent does using StarPanel to coordinate care help everyone stay on the same page?	0	1	2	3	4	5	6	❑
19.	To what extent does using StarPanel to coordinate care improve your ability to accomplish tasks in a timely fashion?	0	1	2	3	4	5	6	❑
20.	To what extent does using StarPanel for coordinating care provide flexibility in how you accomplish your work?	0	1	2	3	4	5	6	❑
21.	To what extent does using StarPanel help convey information to others even though you are not working beside them?	0	1	2	3	4	5	6	❑

Think about *the last 2 weeks…*		Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
22.	When using StarPanel to coordinate care, to what extent is StarPanel clear and understandable?	0	1	2	3	4	5	6	❑
23.	When using StarPanel to coordinate care, to what extent do you find StarPanel to be easy to use?	0	1	2	3	4	5	6	❑
24.	To what extent does using StarPanel to coordinate care require a lot of your mental effort?	0	1	2	3	4	5	6	❑
25.	When using StarPanel to coordinate care, to what extent do you find it easy to get StarPanel to do what you want it to do?	0	1	2	3	4	5	6	❑

Think about *the last 2 weeks…*		Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
26.	How much do your fellow clinicians think that you should use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
27.	How much do your superiors think that you should use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
28.	How much do patients/families think that you should use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
29.	How much do your colleagues use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
30.	How much do external stakeholders or regulators think that you should use a system like StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
31.	To what extent do you think it's your ethical obligation to use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑

Think about *the last 2 weeks…*		Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
32.	To what extent are there barriers that make it difficult or impossible to use StarPanel the way you would like to while coordinating care?	0	1	2	3	4	5	6	❑
33.	How adequate was the training you received to use StarPanel to coordinate care the way you would like to?	0	1	2	3	4	5	6	❑
34.	How adequate are the learning opportunities to help you use StarPanel to coordinate care the way you would like to?	0	1	2	3	4	5	6	❑
35.	How adequate is the technical support to help you use StarPanel to coordinate care the way you would like to?	0	1	2	3	4	5	6	❑
36.	How much does StarPanel disrupt the flow of care coordination when you use it?	0	1	2	3	4	5	6	❑
37.	To what extent is data missing in StarPanel, making it difficult to use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
38.	To what extent is it hard to locate data you need in order to use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
39.	To what extent does the amount of data in StarPanel make it difficult to use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
40.	To what extent do you encounter barriers to using StarPanel to coordinate care related to data entry?	0	1	2	3	4	5	6	❑
41.	To what extent do you encounter barriers to using StarPanel to coordinate care related to the reliability of data?	0	1	2	3	4	5	6	❑

Think about the last 2 weeks …		Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
42.	When you use StarPanel to coordinate care, how well does StarPanel fit with the way you like to do your tasks?	0	1	2	3	4	5	6	❑
43.	When you use StarPanel to coordinate care, how well does StarPanel fit with the goals of your tasks?	0	1	2	3	4	5	6	❑
44.	When you use StarPanel to coordinate care, how well does StarPanel fit with your skills and abilities?	0	1	2	3	4	5	6	❑
45.	When you use StarPanel to coordinate care, how well does StarPanel fit with the professional and on-the-job training you have received?	0	1	2	3	4	5	6	❑

Think about the last 2 weeks …		Not at all	A little	Some	A moderate amount	Pretty much	Quite a lot	A great deal	Don't know
46.	How much do you currently use StarPanel to coordinate care?	0	1	2	3	4	5	6	❑
47.	How many features within the StarPanel system do you currently use to coordinate care?	0	1	2	3	4	5	6	❑
48.	To what extent have you found new ways to use StarPanel beyond how you were trained to use it to coordinate care?	0	1	2	3	4	5	6	❑
49.	To what extent have you found ways to adapt StarPanel beyond how it was originally designed to coordinate care?	0	1	2	3	4	5	6	❑

Please share any thoughts or feelings you have that were not addressed by the survey in the space below.

_____

_____

_____

_____

_____

_____

Thank you for your cooperation in completing this survey.

[If completing survey on paper] Now, please place this survey into the envelope that was provided to you in this packet and return it to the researcher.

THANK YOU!

Form Approved
OMB No. 0935-0208
Exp. Date 03/31/2016

Appendix E: Patient Activation Measures (PAM) Survey

Using Health Information Technology in Practice Redesign: Impact of Health Information Technology on Workflow

Patient Activation Measures Survey

Public reporting burden for this collection of information is estimated to average 12 minutes per response, the estimated time required to complete the survey. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: AHRQ Reports Clearance Officer Attention: PRA, Paperwork Reduction Project (0935-0208) AHRQ, 540 Gaither Road, Room # 5036, Rockville, MD 20850.

The Patient Activation Measure is a short questionnaire with statements about how you may feel about your health. If you are unable to complete the questions on your own, please ask for assistance. Please respond to each statement by placing a check mark in the box that most closely reflects how you feel. Please check only ONE response for each statement. Thank you!

	Strongly agree	**Agree**	**Disagree**	**Strongly disagree**	**Not applicable**
When all is said and done, I am the person who is responsible for managing my health condition.					
Taking an active role in my own healthcare is the most important factor in determining my health and ability to function.					
I am confident that I can take actions to prevent or minimize some symptoms or problems associated with my health condition.					
I know what each of my prescribed medications do.					
I am confident that I can tell when I need to go get medical care and when I can handle a health problem myself.					
I am confident I can tell my doctor concerns I have even when he or she does not ask.					
I am confident that I can follow through on medical treatments I need to do at home.					
I understand the nature and causes of my health condition(s).					
I know the different medical treatment options available for my health condition.					
I have been able to maintain the lifestyle changes for my health that I have made.					
I know how to prevent further problems with my health condition.					
I am confident I can come up with solutions when new situations or problems arise with my health condition.					
I am confident that I can maintain lifestyle changes like diet and exercise even during times of stress.					

Form Approved
OMB No. 0935-0208
Exp. Date 03/31/2016

Appendix F: Summary of Diabetes Self-Care Activities (SDSCA) Survey

Using Health Information Technology in Practice Redesign: Impact of Health Information Technology on Workflow

Summary of Diabetes Self-Care Activities Survey

Public reporting burden for this collection of information is estimated to average 18 minutes per response, the estimated time required to complete the survey. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to: AHRQ Reports Clearance Officer Attention: PRA, Paperwork Reduction Project (0935-0208) AHRQ, 540 Gaither Road, Room # 5036, Rockville, MD 20850.

Thank you for your cooperation in completing this survey. This questionnaire has been designed to gather information about your diabetes self-care over the past 7 days. When completing it, you should think about how you feel and what you think, based on your experiences. Some questions may sound similar to others, but please still try to answer all of the questions. You can leave blank any questions that you do not want to answer. Your responses will be kept confidential under Section 944(c) of the Public Health Service Act. 42 U.S.C. 299c-3(c). That law requires that information collected for research conducted or supported by AHRQ that identifies individuals or establishments be used only for the purpose for which it was supplied.

Your care team will never see your individual responses.

The questions below ask you about your diabetes self-care activities during the past 7 days. If you were sick during the past 7 days, please think back to the last 7 days that you were not sick. If you are unable to complete the questions on your own, please ask for assistance. Please check only one box for each question.

A. Diet **Number of Days**

1. On average, over the past month, how many days per week have you followed your eating plan?	0	1	2	3	4	5	6	7
2. On how many of the last seven days did you eat five or more servings of fruits and vegetables?	0	1	2	3	4	5	6	7
3. On how many of the last seven days did you eat high fat foods such as red meat or full-fat dairy products?	0	1	2	3	4	5	6	7
4. On how many of the last seven days did you space carbohydrates evenly through the day?	0	1	2	3	4	5	6	7
5. On how many of the last seven days have you followed a healthful eating plan?	0	1	2	3	4	5	6	7

B. Exercise **Number of Days**

1. On how many of the last seven days did you participate in at least 30 minutes of physical activity?	0	1	2	3	4	5	6	7
2. On how many of the last seven days did you participate in a specific exercise session (such as such swimming, walking, biking) other than what you do around the house or as part of your work?	0	1	2	3	4	5	6	7

C. Blood Sugar Testing **Number of Days**

1. On how many of the last seven days did you test your blood sugar?	0	1	2	3	4	5	6	7
2. On how many of the last seven days did you test your blood sugar the number of times recommended by your health care provider?	0	1	2	3	4	5	6	7

D. Smoking

Have you smoked a cigarette—even one puff—during the past seven days? Yes No
If yes, how many cigarettes did you smoke on an average day? _____

E. Foot Care **Number of Days**

1. On how many of the last seven days did you check your feet?	0	1	2	3	4	5	6	7
2. On how many of the last seven days did you inspect the inside of your shoes?	0	1	2	3	4	5	6	7

F. Medications	**Number of Days**							
1. On how many of the last seven days, did you take your recommended diabetes medication?	0	1	2	3	4	5	6	7
2. Do you take Insulin? If Yes, On how many of the last seven days did you take your recommended insulin injections?	0	1	2	3	4	5	6	7
3. Do you take pills to lower your blood sugar? If Yes, On how many of the last seven days did you take your recommended number of diabetes pills?	0	1	2	3	4	5	6	7