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Quantitative ethnographic study of physician workflow and interactions with electronic health record systems

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Abstract

This study explores the relationship between primary care physicians' interactions with health information technology and primary care workflow. Clinical encounters were recorded with high-resolution video cameras to capture physicians' workflow and interaction with two objects of interest, the electronic health record (EHR) system, and their patient. To analyze the data, a coding scheme was developed based on a validated list of primary care tasks to define the presence or absence of a task, the time spent on each task, and the sequence of tasks. Results revealed divergent workflows and significant differences between physicians' EHR use surrounding common workflow tasks: gathering information, documenting information, and recommend/discuss treatment options. These differences suggest impacts of EHR use on primary care workflow, and capture types of workflows that can be used to inform future studies with larger sample sizes for more effective designs of EHR systems in primary care clinics. Future research on this topic and design strategies for effective health information technology in primary care are discussed.

Keywords

workflow; primary care; interaction styles; EHR

1. Introduction

1.1. Background

Recent large-scale financial investments in health information technology adoption (Blumenthal, 2009) demonstrate an underlying assumption that electronic health information technologies (henceforth known as "health IT") can contribute to improvements in both quality and efficiency of medical care (Chaudhry et al., 2006). However, current health IT

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systems implemented to help physicians document patient records have the risk of hindering physicians' work. For example, despite the digitization of records and record keeping, emergency department physicians continue to use unofficial, paper charts to support their cognitive work (Wears, 2008; Cheng et al., 2003). This indicates a work scenario where the benefits of technology may be lost due to the costs of a new work practice (Cheng et al., 2003). In primary care health systems, health IT typically take the form of the electronic health record (EHR) computer systems that care providers access to retrieve and document information. There are compelling reasons to use electronic health records (EHR) in healthcare due to its potential to improve quality and efficiency in healthcare (Chaudhry et al., 2006; Mitchell and Sullivan, 2001). However, it is important to consider how this health IT may impact clinical work and healthcare outcomes (Wetterneck et al., 2011). 1.2. Physicians' computer use during primary care visits

Computer use in primary care exam rooms has been found to affect physician-patient communication. For example, physicians may vary their nonverbal and verbal communication behaviors, depending on their style of computer use (Frankel et al., 2005; Montague and Asan, 2012). In other words, the degree to which physicians focus on the EHR could be the degree to which attention resources are directed away from the patient (Margalit et al., 2006). These attention resources normally take the form of gaze and body positioning. These behaviors, directed at the patient or not, affect physician-patient communication, patient-physician rapport, and ultimately, patient outcomes (Hall et al., 1995; Ong et al., 1995). Therefore, use of technology like the EHR during patient visits may have unintended consequences and negatively impact the physician-patient relationship (Mitchell and Sullivan, 2001). The opportunity for interventions such as better EHR system designs or physician training remains. 1.3. Physicians' communication training

While communication skills are significant contributors to patient outcomes (Hall et al., 1995; Ong et al., 1995), not all medical schools integrate communication training into school curricula (Yedidia et al., 2003). There are few standardized assessment instruments that can gauge medical students' use of health informatics systems (Otto and Kushniruk, 2009) and communication performance (Yedidia et al., 2003). Some argue that prominent textbooks on the medical interview have done a poor job of describing how and what the physician might communicate to the patient in a non-verbal manner (Ishikawa et al., 2006). Furthermore, with the wide implementation of EHR in medical settings, a need for teaching EHR-specific communication skills has emerged. However, there have been few, if any, teaching interventions in medical schools for EHR-specific communication skills (Marrow et al., 2009). Physicians develop their EHR use skills based on experience rather than formal training (Rouf et al., 2007), and residents have expressed concern about their preparedness and ability to effectively use EHRs (Otto and Kushniruk, 2009) and integrate EHR use into communication with the patient (Rouf et al., 2007). Current interaction styles with EHR systems are influenced by physicians' non-standardized training of integrating EHR use into workflow. An understanding of current practice and different interaction styles in physicians' work is needed to inform training programs that will help physicians optimally integrate EHR use with patient communication.

1.4. Workflow analysis and information technology

Workflow has been used for decades to evaluate and coordinate the flow of work in a distributed work system (Ellis, 1999). There are different approaches to workflow analysis that include quantitative methods (e.g. collecting timestamped and sequential information) and qualitative methods (e.g. documenting observational information); when used in conjunction, they can help uncover the temporal dynamics of workflow tasks embedded in the flow of work (Zheng et al., 2010). Thus, to understand how a particular work intervention such as a new information technology system may affect or improve the flow of work, workflow analysis can be a useful tool. For example, workflow analysis has been used to understand how information systems can better support cross-functional business processes (Basu and Blanning, 2000), and to assess the efficacy of electronic health IT in a variety of healthcare work settings (Unertl et al., 2010). Workflow analysis is also useful to system designers because it can help identify user needs early in system development (Kushniruk, 2002).

1.5. Why workflow analysis in healthcare?

In the clinical context, researchers have used workflow analysis because of its potential role in health system improvement (Unertl et al., 2010). Workflow analysis can help health professionals better prepare for necessary changes by making work processes visible. Work organization changes, such as the introduction of a new computer system, may impact outcomes like workload and worker satisfaction (Carayon, 2007). In healthcare, this is particularly important because work outcomes have been tied to patient outcomes that are often used as measures of health system improvement (Carayon et al., 2006). As the push for health system improvement continues with the increase of health IT in primary care, physicians are undoubtedly experiencing changes in their work (Mitchell and Sullivan, 2001). Successful adoption of electronic health records will therefore require, in part, further research on how current and future health IT systems impact clinical work (Bowens et al., 2010).

While there are different approaches to workflow analysis, many start from a compiled task list that describes the type of task and potential sequence of tasks. Using data from two observational studies of primary care work in the US, Wetterneck and colleagues (2011) developed a comprehensive list of tasks primary care physicians complete during face-to-face patient visits (Wetterneck et al., 2011). The sequence in which tasks might be performed, and the types of tasks performed were included in this list. The resulting list is a comprehensive collection of tasks divided into 12 major tasks and 189 object of action subtasks. Workflow analysis examines the flow of these tasks, in their actual sequences and relative length of time.

1.6. Workflow tasks in context

A comprehensive task list can inform workflow analyses, but the tasks themselves may vary according to a variety of contextual factors. For example, in the context of EHR use, physical layout of an exam room may affect how a physician engages patients in their medical records (Ventres et al., 2006). Other contextual factors include organizational conditions, such as adequate staffing that would allow physicians to focus more on patient

communication and information gathering, and less on information documentation. Physician differences may also contribute to the EHR context, such as their individual communication and technology interaction styles, which could affect tasks related to the use of technology (Chan et al., 2008; Sykes et al., 2011; Ventres et al., 2005). Furthermore, the technology itself – its interface and features – could impact the manner in which physicians gather and record patient information. Using synthesized approaches to workflow analysis can enrich the visibility of these contextual considerations, and provide a more holistic overview of workflow (Zheng et al., 2010).

2. Methods

The purpose of this quantitative ethnographic study was to understand the relationship between practicing physicians' workflow and their styles of interacting with health IT. Quantitative ethnography is a method that reduces observational data (i.e. video in this study) to distinct measureable units of behaviors and interactions over the observational time period. Behaviors and interactions can range from behaviors related to communication (e.g. nonverbal behaviors) to tasks the subject performs. This method and approach have been used and validated in other studies (Montague et al., 2011). We basically used "video ethnography," or video recordings of participants' ongoing activities in their natural setting (Schaeffer 1995). Then, we used coding to quantify the observational data and conduct workflow analysis. Descriptive analyses of workflow-related tasks and the sequences in which they occurred are presented. These results illustrate the relationships between physician interaction styles and workflow. Findings from this study are intended to inform our understanding of how physicians' interaction styles with health IT systems can impact their workflow. Findings from this study are also intended to contribute to the design of effective health IT systems and physician health IT training systems.

Data from eighteen primary care encounters were collected and analyzed with a quantitative ethnography method. Then, descriptive statistical analysis was used to illustrate findings based on coded data. Video data and quantitative analysis were used to assess the relationship between physicians' interaction style and workflow tasks completed in a primary care encounter. Video records are preferable to direct observation because they accurately record clinical events, allowing researchers to validate their observations, and they allow for the collection of systematic feedback by means of strategic participant review (Seagull and Guerlain, 2003). Video data can also give researchers insights into the consistency between self-assessment and observable behavior.

2.1 Data Collection

Data consisted of videotaped health encounters with patients who sought care in primary care clinics with their primary care physicians, 18 clinical encounters were included in the study. All encounters were recorded with high-resolution video cameras from multiple (three) angles to capture individual (patient and physician) and group interactions. Informed consent was obtained from both patient and physician participants. The study protocol and activities were approved by university and clinic Institutional Review Boards (IRB) and HIPAA (Health Insurance Portability and Accountability Act) regulations were followed.

2.2. Participants

Six physicians and eighteen patients participated in the study. Patient ages ranged from 25 to 65. The physician group included four males and two females (Mean= 45.5 years old). The physicians were classified into three EHR interaction styles: technology-centered, human-centered and mixed interaction (Montague & Asan, 2012). There were two physicians in each group and each physician saw six patients. Classifications were based on a quantitative assessment of the amount of time the physician spent typing and gazing at the computer in the visits which is described in section 2.6. All physicians used the same EHR system.

2.3. Coding

2.3.1. Video coding and reliability—Coding is the process of reducing large amounts of complex data into quantifiable units of analysis (Miles and Hubberman, 1994). Coding has been used in prior observational research in human factors (Zandbelt et al., 2005). In this study, a validated list of workflow tasks performed by primary care physicians during patient clinic visits (Wetterneck et al., 2011) were used as unit measures in the coding scheme. Two coders coded each video capturing a primary care visit according to the tasks that occurred. Start and stop times for each task were obtained this way.

Reliability scores were calculated conservatively: scores were calculated at one-second levels. In other words, if two coders coded the start of an event in the period of $X \pm 1$, it was counted as an agreement, if not, reliability was reduced. Each coder was trained with practice videos. When the coder achieved at least a 0.60 Kappa reliability score, they were allowed to code research data. Ideally, a Cohen's Kappa value of 0.60 is standard and above 0.75 is considered an excellent value (Bakeman, 2000). Each week, coders coded a single video and a total of four videos were coded to check and maintain the required reliability. The reliability scores of the videos ranged from 0.63 to 0.76.

2.3.2. Coding scheme—A coding scheme was used to define the presence or absence of a task (Table 1). Each code included a subject (the physician) and a task (what the physician did during the visit).

Each task was coded temporally, from beginning to end. Figure 1 depicts a sample visit workflow based on the temporal coding of a visit, though physicians did not always perform all tasks listed.

2.4. Definition of tasks

Each of the validated tasks in the list included several subtasks. Some of these subtasks were illustrated in the parenthesis (Table 2). The definitions and guidelines used during the coding for each task were also provided to coders by the research team.

The major tasks were “Gather info”, “Review info”, and “Document info”. The list of tasks was ordered in a sequence to represent a standard patient visit, when deviations to the sequence occurred during analysis, tasks were coded in the order they occurred in the data. However, many deviations to this sequence were observed (Wetterneck et al., 2011; Zheng

et al., 2010). Previous studies have not addressed the time physicians spend on each task (Wetterneck et al., 2011).

2.5. Data reduction and analysis

The start and stop times for each visit were defined based on the physician's entrance or exit of the room. Physical exams were thus included as part of the visit. Several methods were used to code the physicians' workflow:

1. Videos were coded based on a workflow task coding scheme derived from the Wetterneck et al. (2011) study.
2. Temporal-based coding established the time spent on each task, and the sequence of the tasks.
3. The list of tasks in developed by Wetterneck et al. (2011) was ordered in a sequence to represent a standard patient visit. However, tasks were coded in the order they occurred in the data if any deviations to the sequence were encountered during analysis.
4. Some tasks occurred simultaneously, such as gathering information and documenting information, or looking up medication options while ordering medicine. Concurrent tasks were noted when they occurred.

Using the coded data, it was possible to obtain the frequency and duration of each task. The percentage of time tasks took in each visit was also calculated. To investigate the relationship between each task and interaction style (defined in 2.6.), regression analysis was conducted. Finally, a t-test with the ($\alpha = .05$) level of significance was used to determine if the amount of time spent on a task was significantly different between the interaction style groups.

2.6. Classification of physicians' EHR interaction style

Previous studies have classified physicians' interaction styles based on their amount of keyboarding and gazing (Margalit et al., 2006) with labels such as "heavy typers," "moderate typers" and "light typers." A previous study classified physician interaction style using a multi stage approach: first physician typing and gaze behaviors were calculated temporally through each of their patient visits, second behavior duration and percentage of the visits these behaviors occurred during the visits was calculated, cluster analysis grouped the visits based on typing and gaze behavior, finally qualitative analysis analyzed videos holistically for themes. From this analysis three distinct physician interaction styles emerged, technology-centered, mixed interaction, and human-centered, they are described in detail in Montague and Asan (2012). Classification criteria for interaction styles were established based on typing behavior: $> 15\%$ of the visit length for the technology-centered interaction style, $5\%-15\%$ for the mixed interaction style, and $< 5\%$ for the human-centered interaction style (Montague and Asan, 2012). In that study, the technology-centered group gazed at the computer 49.6% of the visit length, and typed 21.6% of the visit length. Physicians in this group spent more time typing and gazing at the computer during the visit. The mixed interaction group, on the other hand, shifted their attention and body language

between patients and the technology throughout the visit. The mixed interaction group's gaze was reported at 34.8%, and they typed during 8.5% of the visit length. The human-centered group spent a minimal amount of time typing, and focused mostly on the patient, gazing at the computer 24.9% of the visit length and typing only 2.8% of the visit length.

3. Results

3.1. Task times across interaction styles

Descriptive statistical analyses were conducted to obtain range and mean estimates of each task within the entire sample and the interaction styles (Table 3). For overall sample, physicians on average spent 35.5% of the visits gathering information, 11.7% of the visits reviewing information and 20.44% of the visits documenting information per visit. Standard deviations were reported for the major tasks, and were not reported for the tasks “give patient,” “look up,” and “order,” since they were not observed in at least 30% of all encounters.

The standard deviations for the entire sample indicated high variations among the physicians. Therefore, it was of interest to assess the variability across the different interaction style groups (Table 3). The technology-centered group showed the greatest amount of variability for the major workflow tasks (gather information, document information, and review information). The other two groups were more consistent on time spent on major tasks. Because the length of each visit varied, standard deviations for the percentages of the total visit time were also reported for richer understanding of the variability.

3.2. Interaction style and individual workflow tasks

3.2.1. Gathering information from the patient—“Gathering information” occurred in all visits observed, and has been classified as a major task in primary care encounters (Wetterneck et al., 2011). Time spent gathering information in each interaction style varied significantly across interaction style groups (technology-centered= 48.80%, mixed = 23.14%, human-centered= 35.41%). Significant differences were found between the technology-centered and human-centered groups ($p= 0.049$), as well as technology-centered and mixed interaction groups ($p= 0.006$). The technology-centered group tended to gather information continuously during the first half of the visit. Human-centered physicians also tended to gather information during the first half of the visit, and conducted additional gathering during the second half of the visit. The mixer group tended to focus on gathering information during the first half of the visit (see figure 1) The frequency of the gathering information task also differed in each interaction style: technology-centered (4.3 times per visit), mixed interaction (2.6 times per visit) and human-centered (5.2 times per visit).

3.2.2. Reviewing patient information—The technology-centered group spent the greatest amount of time reviewing patient information (15.68% of the visit) whereas the human-centered group had the lowest percentage (9.17% of the visit). However, there was no statistical difference for time spent reviewing information between interaction styles. The frequency of reviewing information was also the highest for the technology-centered group

(4 times per visit), followed by the mixed interaction group (2.2 times per visit), and the human-centered group (1.8 times per visit).

3.2.3. Documenting patient information—Time spent documenting information in each interaction style also varied across interaction style groups (technology-centered = 31.59 %, mixed = 13.23 %, human-centered = 13.60 %, of the visit) For time spent documenting information, a significant difference was found between the technology-centered group and human-centered group ($p= 0.015$), and the technology-centered group and mixed interaction group ($p= 0.008$). No significant difference in this task was found between the mixed interaction group and the human-centered group ($p= 0.511$).

The relationship between gathering information and documenting information was also examined for each interaction style. The technology-centered group spent 48.8% of the visit gathering data and 31.59% of the visit documenting the gathered data. The mixed interaction group spent 23.14% of the visit length gathering information and 13.23% documenting information. The human-centered group spent 35.41% of the visit length gathering data. However, they only spent 13.60% of the visit length documenting patient information.

For the technology-centered group, documenting information and gathering information occurred mostly simultaneously. The mixed interaction group documented information independently from gathering information, and mostly during the second half of the visit. Finally, the human-centered group generally documented information independently from gathering information. This group tended to gather information first, with brief documentation, then conduct the majority of documentation during the second half of the visit.

3.2.4. Remaining tasks—The remaining minor tasks (see Table 2) were examined. The “perform” task in this study was the physical exam conducted by the physician. The amount of time spent on this task was similar for each interaction style. Results show that the human-centered and mixed interaction group spent much longer time (30.01% of the visit, 26.50% of the visit) than the technology-centered group (14.69% of the visit) during the “recommend/discuss treatment options” task, although the frequency of this task was similar across groups (2.5, 2.4, 2.6, per visit). In the recommend/discuss treatment options tasks, a significant difference was only found between the technology-centred and human-centered groups ($p=0.016$). The “order” and “wrap up” tasks, which occurred in nearly all visits, had no significant differences between groups. Finally, “printing” and “giving patient advice or instruction” took up the largest percentage of time in the mixed interaction group (14.32%) and a smaller percentage in the other two groups, though there was no statistically significant difference found.

4.0. Discussion

Using quantified ethnographic methods, significant differences were found in the times physician groups spent completing major tasks in primary care workflow. Results also showed higher variability in the technology-centered group than in the human-centered or mixed interaction groups. The technology-centered group is defined by its higher average

mean of technology use. Therefore, these findings support the notion that integration of the EHR system into physicians' work creates highly variable workflows, and that EHR influences workflow. Assessing physician interaction styles and workflow thus plays an important role in understanding the impact EHR systems may have on primary care delivery.

4.1. On the information gathering task

Results also showed that the technology-centered group spent the greatest amount of time completing the task "information gathering." This supports previous findings that indicate EHR use can encourage physicians to gather more data (Sykes et al., 2011). Technology-centered physicians tended to gather more information by asking follow up questions and typing simultaneously. One drawback of the technology-centered interaction style may be disengagement with the patient while typing. Attempting to engage in multiple tasks, known as multitasking, has been said to be the opposite of "mindful presence" and has been implicated as sources of error (Lown and Rodrigez, 2012). Human-centered physicians, similar to the technology-centered group, spent 35.41% of the visit length for data-gathering, though much less time documenting. The mixed interaction physicians spent the least amount of time data-gathering during the visit (23.11% of the visit). It should be noted that several factors in addition to physician style may affect time spent documenting, such as the type of visit, the chief complaint of the visit, the content of information, the physicians' length of relationship with the patient, and the physicians' familiarity with the case.

4.2. On the information reviewing task

Reviewing information during the visit varied in percent visit time (technology-centered = 15.68%, human-centered = 9.17%, mixed = 10.28% of the visit) and frequency (technology-centered = 4 times per visit, human-centered = 1.8 times per visit, mixed = 2.2 times per visit). While the technology-centered group appeared to review information the most, this may have been a by-product of interacting with the EHR more often than the other groups. The other two groups were more consistent with each other and reviewed patient information around two times per visit.

4.3. On the documenting information task

Results also showed a distinct difference between the technology-centered group and the other two groups in the documenting information task. Documenting information is essential for keeping accurate patient records. Because clinic visits are opportunities to gather critical patient information, documentation is the main goal behind keyboarding. The technology-centered group spent the highest percentage of the visit (31.59 % of the visit) in documentation tasks, more than the sum of the other two groups (13.6% and 13.23%, of the visit).

The drawback for the human-centered interaction style for the documenting information task is the potential loss of information that may occur with physicians who choose to document after the visit (Pizziferri et al., 2005) and have to rely more on their memory. Finally, the mixed interaction group spent 23.14% of the visit gathering information and 10.75% documenting information, using mostly the EHR system for documentation. This group

appeared to use the EHR system with limited disengagement from the patient, which suggests these physicians may have found an appropriate ratio between EHR use and patient engagement.

4.4. On the recommend/discuss treatment options task

Significant differences for the remaining tasks were not found, except in the recommend/discuss treatment options task. The human-centered and mixed interaction group spent almost twice as much time as the technology-centred group in this task. This indicates human-centered physicians took more time to engage the patient and discuss treatment options. This may be a disadvantage of the technology-centered interaction style, since consultations are important patient-education and empowerment opportunities, and may be considered part of the shared decision-making process between physician and patient (Ong et al., 1995).

4.5. Limitations

This study has some limitations that should be considered. First, the sample size is small, since it was an exploratory study and data were collected with a single EHR system and physician population (i.e. primary care physicians), so the generalizability of these findings and the classification system used should be validated through further research with larger sample sizes, in similar contexts. The small sample size is mainly due to the extremely time consuming nature of coding the video data; therefore, videos were strategically randomly selected from a larger sample of videos. Additional analysis that incorporates physician activities and features of their work system outside the clinic visit could enhance the findings. For instance, it would be beneficial to see if all necessary information was documented in post-visit documentation. Specifically, future studies should examine time spent on information documentation and reviewing patient information and other activities associated with primary care workflow that occur outside the patient visit. In addition, this study did not examine the possible effects of other factors such as gender, race, nature of the disease, and length of the patient-physician relationship in the interaction between physicians and patients. Future studies should investigate the possible effect of those factors, and other patient-related characteristics such as the purpose of the visit, on physicians' workflow.

5.0. Conclusion

The main findings from this study suggest that physicians' interaction styles with EHRs influences their workflow, and that integration of the EHR system into physicians' work can create highly variable workflows. Understanding how physicians' interaction styles diverge thus plays an important role in identifying specific features of health IT systems that can better aid physicians to effectively complete important workflow tasks. Furthermore, it may be worthwhile to develop standardized physician health IT training systems to develop physicians' skills and effective use of EHRs while communicating with patients.

Since the United States healthcare system is transitioning to computer-based systems, it is of immediate importance to optimize EHR system design for more effective patient encounters

(Lawler et al., 2011). An EHR system that is difficult to navigate may demand more attention from the physician, drawing the physician away from the patient, or the physician may choose to reject the system altogether. Therefore, it is important to consider different EHR systems have the potential to produce various interaction styles between physicians, depending on system design and implementation.

Designers of future systems may use this study's method of discerning interaction styles to better conceptualize use differences and understand technology's impact on physician workflow. An effective EHR design would leverage what is known about the physical, cognitive, and social needs of physicians to facilitate effective interaction with both the patient and the technology (Lawler et al., 2011). Beyond this, and consistent with this study's findings, an effective design would also maximize knowledge of physician interaction styles to avoid supporting or creating problematic workflows. For example, understanding when simultaneous tasks occur may reveal the context in which health IT systems could better support physicians' work by offloading cognitive workload.

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- Differences exist in the duration physicians completed workflow tasks.
- Technology centered doctors have the highest documentation time.
- Differences in workflow were related to physicians' computer use style.
- Some physicians do not document the information they gathered in the visit.

Figure 1.
Task workflow of a primary care visit based on a temporal coding

Table 1

Coding scheme

Subject	Task
Physician	Gather information from patient
	Review Information
	Document Information
	Perform
	Recommend/Discuss Treatments
	Look Up
	Order
	Communicate
	Print/Give patient
	Wrap up

Table 2**The list and definitions of tasks**

1. Gather information from patient (Chief complaint, problem information, patient's current medications, etc.)
<i>1.1. Physicians ask questions about the current status of the patient that relates to medical issues and purpose of the visit.</i>
i. "So, what's on our agenda?"
ii. "How are you doing with the medications?"
iii. "Have you had any issues with it since the last visit?"
iv. "Were you keeping up with the prescriptions?"
<i>1.2. Physicians make eye contact with patients, type in information, ask follow up questions and review past information while gathering information.</i>
2. Review Information (Chief complaint, problem information, patient's current medications, medications, tobacco use etc.)
<i>2.1. Physicians look at the computer to check the prescription or last visit information. Questions regarding past medication or treatment and its effects are generally classified here.</i>
i. "You were taking ~~~~ right?"
ii. "How much of the ~~~ did I prescribe you last time?"
iii. "Let me just take a look at the records"
3. Document Information (Chief complaint, problem information, patient's current medications, medications, tobacco use etc.)
<i>3.1. Typing or writing</i>
4. Perform (Procedure, vitals, physical exam, hand sanitization etc.)
<i>4.1. Physicians establish a physical contact with the patient for diagnosis purposes.</i>
5. Recommend/Discuss Treatment options (Medication, diet/exercise, test/preventive screening, procedure, follow-up appointment etc.)
<i>5.1. Physicians suggest a series of treatments or actions as follow up procedure. This does not include the information of each treatment or medication that is being given to the patient. Patients often actively ask questions and give some feedback on the treatment options given.</i>
i. "I recommend you do ~~~ and ~~~ before you take this medication"
ii. "So if you think this would work, I would write a letter to the department for a diagnosis"
iii. "Let's do this..."
iv. "Here are some options I think you would like"
<i>5.2. Physicians may take notes or type for an order form simultaneously.</i>
6. Look Up (Treatment information, referral physician, drug information etc.)
<i>6.1. Physicians search for information on treatments, medications or physicians. Physicians would be gazing into the computer as they do in reviewing but the physicians would often say they are looking for information.</i>
<i>6.2. This task may occur concurrently with other tasks.</i>
7. Order (Medication, test, referral to specialist, procedure etc.)
<i>7.1. Ordering of medication or diagnosis testing.</i>
<i>7.2. Physicians would often ask the convenient pharmacy they would also state that they are ordering the medications.</i>
8. Communicate (Nurse, other healthcare provider)
<i>8.1. Physicians talk either in person or on the phone with an individual from a third party (nurse or other physician).</i>
9. Print/Give patient (advice, instructions, paper prescription, medication information/instructions, test order form, etc.)
<i>9.1. Physicians give information or printouts or forms to the patient. Physicians also go through diagnostic information such as x rays or blood testing samples.</i>
10. Wrap up (Walk patient, log out of computer/EHR)
<i>10.1. Physicians usually change in tone and ask for further questions. Generally, the topic of conversation deviates from the medical issues.</i>

Note: The workflow tasks which are written in bold adapted from "Development of a primary care physician task list to evaluate clinic visit workflow," by Wetterneck et al, 2011, BMJ Quality & Safety.

Table 3

Mean estimates of each task for overall sample and each interaction group

Workflow task	Entire sample			Human Centered			Technology Centered			Mixed		
	Average time (sec) (SD)	(%) (SD)		Average time (sec) (SD)	(%) (SD)		Average time (sec) (SD)	(%) (SD)		Average time (sec) (SD)	(%) (SD)	
Gather information from patient	407.06 (244.6)	35.55 (16.6)		403.88 (138.7)	35.41 (12.2)		606.92 (271.9)	48.8 (17.8)		213.84 (132.0)	23.14 (9.1)	
Review patient information	136.59 (116.3)	12.5 (8.3)		107.78 (66.51)	9.17 (3.8)		211.3 (161.8)	15.68 (9.6)		90.7 (77.97)	10.28 (7.9)	
Document patient information	207.70 (182.7)	21.57 (16.1)		136.4 (93.3)	13.60 (5.60)		363.93 (188.02)	31.59 (13.9)		91.55 (72.74)	13.23 (7.1)	
Perform	108.38 (54.16)	10.51 (4.8)		99.62 (57.24)	8.89 (6.2)		119.2 (37.14)	9.2 (2.1)		107.01 (68.21)	12.19 (5.5)	
Recommend/Discuss Treatment options	273.34 (179.7)	24.5 (13.5)		374.4 (217.2)	30.01 (12.4)		210.05 (137.4)	14.69 (9.3)		235.79 (158.4)	26.5 (12.8)	
Look Up	47.83 (NA)	4.01		55.31 (NA)	21.27		25.43 (NA)	2.82		40.31 (NA)	4.6	
Order	95.94 (NA)	9.12		108.94 (NA)	11.18		103.89 (NA)	6.45		75.62 (NA)	9.75	
Print/Give patient	109.94 (NA)	10.41		105.29 (NA)	7.5		66.66 (NA)	4.64		136.24 (NA)	14.32	
Wrap up	55.53 (34.7)	5.7 (4.3)		54.61 (30.38)	4.85 (2.6)		64.51 (35.83)	5.68 (3.3)		47.48 (41.59)	6.58 (4.6)	

Note: Percentages represent the duration of the tasks out of the total visit time.