Organizational routines, innovation, and flexibility:

the application of narrative networks to dynamic workflow

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Abstract

Objective

The purpose of this paper is to demonstrate how current visual representations of organizational and technological processes do not fully account for the variability present in everyday practices. We further demonstrate how narrative networks can augment these representations to indicate potential areas for successful or problematic adoption of new technologies and potential needs for additional training.

Methods

We conducted a qualitative study of the processes and routines at a major Academic medical center slated to be supported by the development and installation of a new comprehensive HIT system. We used qualitative data collection techniques including observations of the activities to be supported by the new system and interviews with department heads, researchers, and both clinical and non-clinical staff. We conducted a narrative network analysis of these data by choosing exemplar processes to be modeled, selecting and analyzing narrative fragments, and developing visual representations of the interconnection of these narratives.

Results

Narrative networks enable us to view the variety of ways work has been and can be performed in practice, influencing our ability to design for innovation in use.

Discussion

Narrative networks are a means for analyzing and visualizing organizational routines in concert with more traditional requirements engineering, workflow modeling, and quality improvement outcomes measurement. This type of analysis can support a deeper and more nuanced understanding of how and why certain routines continue to exist, change, or stop entirely. At the same time, it can illuminate areas in which adoption may be slow, more training or communication may be needed, and routines preferred by the leadership are subverted by routines preferred by the staff.

Author Keywords: Collaborative systems, workflow analysis, narrative networks

INTRODUCTION

Recently, medical institutions worldwide, and particularly in industrialized nations, have come under increasing pressure to provide greater evidence of patient health outcomes and to make patient care more efficient through the introduction of Electronic Medical Records (EMR) systems. Unlike their predecessors, which also house electronic records of medical data, these systems are comprehensive solutions that generally include the "chart" as well as scheduling, test ordering and results, imaging, and prescription data. EMR systems are inherently collaborative in nature, often serving as a communications system amongst both clinical and non-clinical staff and a technological infrastructure for the standardization of workflow amongst a wide variety of stakeholders. The medical record represents the enactment of the "body politic" of both individual patients and the clinic itself [1]. Thus, EMR systems include many areas and activities adjacent to but largely outside of the information traditionally considered part of the legal medical record. These comprehensive systems require detailed understanding of organizational practices beyond simple considerations of technological capabilities and efficiency for successful adoption and use [2].

The work of hospitals is predicated on the idea that a highly heterogeneous group of people with disparate goals and working styles can, and indeed must, come together with one overarching goal: high quality patient care. These groups must find a way to communicate and share information as part of their efforts in caring for the patient. However, they must do so in a way that is locally and institutionally acceptable in terms of both individual goals and hospital or legal policy. The largely paper-based medical records are the primary site of this communication and coordination. Importantly, these functions go beyond direct patient care, including the coordination across different organizations, billing and insurance administration, shift scheduling, and more. It is perhaps unsurprising then that, serving so many different needs and professional responsibilities, and being so centrally implicated in the work of many people, the records are the site of a great deal of local customization and adaptation, becoming highly valued objects in their own right.

This complexity also means that the change to EMR is not so simple as a "swapping out" of the current IT infrastructure for this new monolithic system. Instead, there are substantial challenges that necessitate an examination across the hospital at how the body and the clinic are enacted, contested, and developed in, through, and around the medical record and the work required to produce it. Medical centers hoping to implement comprehensive EMR systems must take comprehensive stock of their current IT infrastructure and work practices. The all-encompassing reach of EMR systems requires taking a holistic view of healthcare provision, even at the same time as an increasing number of localized, specialized practices and procedures are incorporated. This creates a significant tension in both analysis and design. A comprehensive approach to EMR system design and development must somehow also accommodate the difference and diversity across different units, the different local needs of

separate stakeholder groups, and the variability and flexibility necessary to get work done under ever-changing constraints. Balka *et al.* [3] note that hospital information systems should be designed to enable, rather than constrain, local variations in the organization of work, temporal ordering, and flow. Hartswood *et al.* [4] likewise note that medical technologies are most important to examine *in use* as they are changed and adapted. In this paper, we build upon these arguments and focus on ways of understanding organizational work as a lived, dynamic practice.

In this work, we were interested in the ways in which patterns of action surrounding Health IT coevolve with the systems themselves and the organizational context in which they exist. Understanding the patterns of action in these settings to design or refine compex Health IT systems requires in depth engagement with and active participation of those individuals who do (or will) use these systems [5, 6, 7]. In particular, we explore the use of "narrative networks" [8, 9] as a method for modeling and understanding variation *in use.* Narrative networks are complementary to traditional process models and workflow diagrams for understanding organizational processes as they unfold in organizations, highlighting the flexibility, fluidity, and multiple perspectives that characterize the everyday enactment of processes. Unlike other graphic representations of work, such as Business Process Modeling Notation (BPMN) that are used to specify business processes [10], narrative networks are analytical tools to understand both current practices and the potential new narratives and routines that could result from changes in either human behavior or the context in which behaviors occur. They can be used to augment formal process models to focus on organizational processes *in practice*. Narrative network analysis sees organizational life as a "network of stories" and seeks to capture and represent the complex interrelationships between different actors' perspectives on how work is (and can be) done. Stories have temporal and logical structure and are crafted from particular points of view and for particular audiences. However, they have marked variability in the particular ways in which they can be performed. Rather than embodying the "one true way," narrative networks show, first, the interwoven perspectives of different stakeholders, and, second, the many different ways that apparently standardized processes might, in practice, unfold.

To demonstrate the power of narrative networks, we use data from extensive fieldwork across multiple sites within one major academic medical center, which we call UniHospital, during a time in which administrators and clinicians were preparing for the implementation of a comprehensive EMR system. Both the Information Services department at UniHospital and hospital leadership are aware of the risks of such a huge undertaking. At the time of our study, UniHospital was in the course of an extensive workflow development and deployment exercise, borrowing from "Best Practices" for large-scale system integration, document management, and requirements engineering [11]. A workflow management system "defines, manages, and executes workflow processes through execution of software whose order of execution is driven by a computer representation of the

workflow process logic" [8]. Over the years, workflow modeling and workflow management have become core to supporting long-term processes in complex organizations such as UniHospital [13, 14, 15, 16].

However, as Mueller *et al.* note "conventional workflow management systems do not provide sufficient flexibility to cope with the broad range of [events] that may occur during workflow execution." [17]. In the process of conducting our fieldwork, which included review of workflow documents prepared as a precursor to the development of workflow management tools within and alongside the EMR, we have found that the language and techniques of process modeling are of limited utility in understanding the activities these models are meant to represent. Others have found similar challenges in representing dynamic medical workflows (*e.g.,* [17, 18]). There can be significant mismatches in goals, interfaces, language, and standards between workflow systems and guideline systems [19]. Thus, researchers and process modeling standards organizations have attempted in recent years to allow for greater flexibility and more dynamic interactions, such as from non-interrupting events and exception handling [20]. The solutions to emerge from these insights support "flexible guidelines" [18] or "reactive or predictive adaptation" [17] but are still primarily framed and technologically based on the underlying concepts and capabilities of workflow modeling and management.

Narrative networks can augment these models in practice. They may serve as more realistic models of organizational routines that autonomous individuals dynamically choose based on their professional training and knowledge of particular situational dependencies. Narrative networks provide a means for understanding routines as "generative systems that can produce patterns of action based on local judgment and improvisation by actors" [8]. In this paper, we describe our use of narrative networks as a means for conceptualizing the variable routines of UniHospital. We further describe the implications of this perspective for examinations of HIT systems more broadly, closing with some suggestions on how to use this perspective in design.

APPROACHES TO REPRESENTING ORGANIZATIONAL PROCESSES

Formal process models, which break organizational activities into sequences of steps, are central representational tools for organizational processes. Workflow systems embed these process models in software to streamline organizational work. However, several researchers have noted the shortcomings of approaches to systems design in healthcare that are heavily focused on traditional process modeling. Berg and Toussaint, building on a sociotechnical understanding of the development and use of medical technologies, use "reverse engineering" of the paper medical record to reveal the complex ways in which the medical record is constituted and used [21]. In this work, they note that if viewed as a model, the paper medical record may be fairly comprehensive—covering clinical data and knowledge, decision-making practices, organizational procedures, and so on—but still "highly uneven and utterly eclectic." Furthermore, communication [22], discourse, and argumentation [23] are

fundamental to the way medicine is practiced. Thus, both the medical record and the practices surrounding it are much more collaborative than a standard workflow model might imply. Finally, no patient—and certainly no patient-clinician dyad—ever follows exactly the same pattern of communication and care as another [24, 25]. Thus, perhaps a complete 'business' model of work is not the most appropriate precursor to the design and development of a successful EMR system.

Although useful in many respects, traditional workflow-style process modeling is insufficient for understanding many of the nuances of actual work practices in complex environments. An underlying problem with traditional workflow modeling is that the method is based upon a creating a unitary understanding of "the organization", or in this case, "the hospital". Thus, workflow systems may be lacking in flexibility and poorly matched with the overall goals of the organization. They typically have been designed to support comprehensive but abstract modeling of discrete processes that can be artificially simplistic. This kind of simplicity engenders a host of benefits to large organizations, such as maintaining audit trails that will satisfy legal and regulatory pressures and creating cross-departmental interoperability with information systems. A unitary vision of workflow also yields a more tractable design space for applications as well as infrastructure. However, despite well-intentioned conversations with stakeholders that often yield detailed views of work including forks and loops to illustrate some alternative

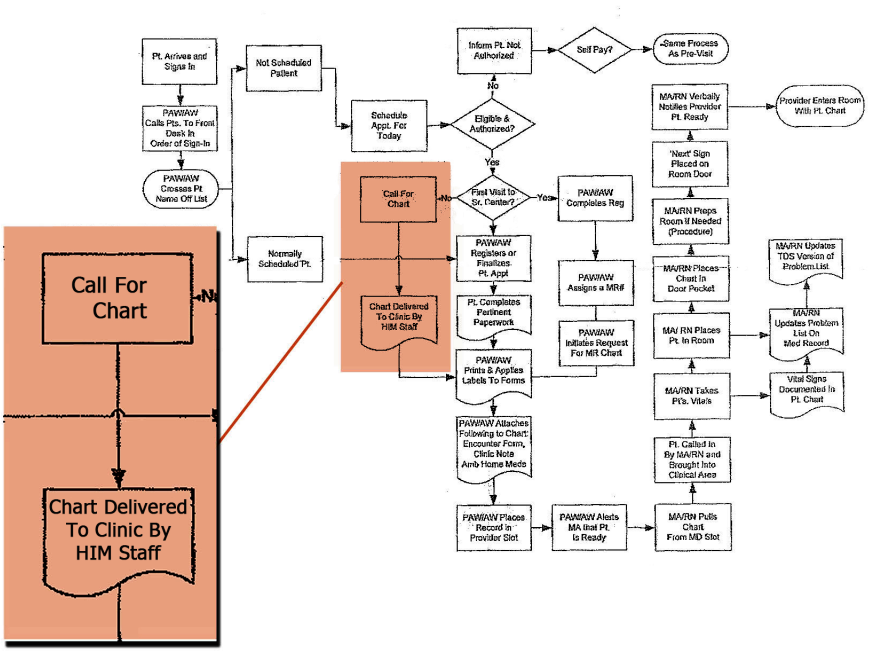


Figure 1: Workflow model of the Check-In Process for one of our outpatient clinics, with chart request and receipt highlighted and enlarged.

decisions and actions, differing perspectives and dynamic decision-making paths are often homogenized through the creation of a single workflow diagram created by the design team.

To understand why a single perspective is inadequate we need to reconsider what we are modeling. If we are modeling a workflow, whose workflow are we modeling? Doctors, nurses, and administrators are continually working in a coordinated fashion working with many of the same patients, records, systems, and spaces, but their organizational routines and situational awareness is very different. Dealing with the admittance of a new patient entails very different activities and situational dependencies depending on ones role and perspective. Rather than continue to modify the extensive work on workflow, guidelines, and routines, we have found Pentland and Feldman's *narrative networks* technique a useful way to elaborate the conventional formulations of organizational processes as both technological and social phenomena [8]. Drawing on structuration theory [26], Actor-Network Theory [27, 28], and the theory of organizational routines [29, 30], narrative networks explicitly focus on the variety of performances that might be or have already been [8]. Rather than presenting a single narrative or account, narrative networks are composed of "narrative fragments" from many different perspectives and many different stakeholders, showing how each partial and incomplete view contributes to a holistic lived practice. Where a workflow model represents the "view from nowhere," narrative networks attempt to represent the "view from everywhere"; they show how different perspectives interrelate by breaking down narratives to their constituent "fragments" and stitching them together into a network that goes beyond any individual view. Development and use of narrative networks can augment traditional workflow methods to create models that account for variable routines. They indicate the modularity of individual instances of technology use and demonstrate how these instances can be recombined. Examination of narratives and narrative networks have been used in other domains (*e.g.,* in examining the ability for organizations to sustain innovation [31], in the development of ubiquitous computing environments [32], and in understanding emergent democratic processes in neighborhood planning [33]). Additionally, previous work used narrative network analysis to examine the implementation of an EMR system in a private hospital's family practice [34]. However, ours is the first work using narrative networks to analyze and represent the patterns of action in a large academic medical center.

Use of narrative networks enables the explicit examination of tensions between the "dead" and "live" routines of UniHospital [35]. According to Pentland and Feldman, dead routines are those rigid and sometimes mindless routines that can be documented and saved. Dead routines in our case include sequential lists of tasks and actions, many of which the hospital administration hopes to codify into the EMR system itself thereby preventing clinicians from enacting the routines in manners different from their expectations. Live routines, on the other hand, are those that are dynamically shaped by people with

individual agency capable of learning from their experiences. In our case, an example of a "live" routine would be the case of a physician taking a history but choosing not to ask a patient about smoking, knowing already either that the patient has never smoked and is unlikely to start or that the patient has been smoking for multiple decades and has no desire to stop. In this case, one that emerged in our fieldwork, clinicians simply mark the "yes" box regarding whether they had provided advice and discussion around smoking thereby circumventing the dead routine embedded into the artifact of the records system.

When considering live organizational routines, Pentland and Feldman stress the importance of examining both the ostensive and performative aspects. Ostensive aspects include the generalized, abstract functions and divisions of responsibility that the processes notate. Information about these aspects of a routine would be present in a procedure manual and offer a greatly simplified view of work practices. Performative aspects include the practical, embodied actions that are actually carried out [8]. These tend to be more detailed, mundane, and individualized. That is to say, performative aspects are the lived experience of activities. Where the ostensive concerns what is achieved, the performative concerns what is done.

Neither of these can be understood alone; the performative does not substitute for the ostensive any more then the ostensive subsumes the performative. To make this more concrete, lets take the example of making an appointment with a physician at UniHospital. The performative acts would include a particular patient X picking up the phone, dialing the numbers to the patient appointment scheduling line, requesting an appointment with a particular physician Y, and eventually negotiating the exact date and time of that appointment. At the same time, the performative acts for the patient scheduler would include a particular operator Z answering the call from patient X, checking the schedule for physician Y, negotiating the details of the exact date and time of that appointment, and typing the details into the appointment scheduling system. On the other hand, "the ostensive aspects consist of the abstract, generalized understandings of the participants," [8] which in our example is the general *idea* of making an appointment and the generalized steps required to do so for each of the patient and the scheduler. Thus, the ostensive provides a resource upon which each actor may draw to determine and perform a set of actions [30].

RESEARCH SITE AND METHODS: A NARRATIVE NETWORK ANALYSIS OF ORGANIZATONAL ROUTINES AT UNIHOSPITAL

UniHospital is an academic research hospital with more than 3500 employees, including more than 400 physicians, working out of a combination of community clinics and a 450-bed hospital. There are approximately 50 departments and research centers at UniHospital, all serviced by one Information Services organization.

Within UniHospital, there is a culture of independence between researchers and departments with each vying for limited resources from the hospital, its associated university, and external funding agencies. Furthermore, in the United States, the legal

and regulatory environment surrounding healthcare and healthcare research hold clinicians and primary investigators personally responsible for accurate records and patient or human subjects safety. This personal responsibility has led those clinical and research physicians who can afford to do so to hire individual IT support, create their own records management software, and in many cases purchase their own imaging or recording equipment and software. These systems have then grown organically over years or even decades. Thus, the current socio-technical infrastructure of UniHospital includes a massive network of artifacts, people, goals, tasks and more all interwoven in complex ways. The vision of the EMR project there is to create a new unified system of processes, technological tools, and data structures while removing the need for support and maintenance of the disparate set of systems and practices already in place. This vision—and related technological infrastructure—is scheduled to be completed over nearly a decade in phases that include clinical, research, academic, and community resources and efforts.

Using the data from interviews and fieldwork, we adopted the narrative network approach, in which we first identified exemplar processes to understand in more depth (*e.g.,* requesting a medical chart, scheduling a patient for an appointment). These processes have at their heart a shared purpose amongst all those individuals and technologies involved in them, making inherent boundaries around our storyline or narrative. We then identified particular viewpoints from which to explore these narratives and the actants and actions for these tasks from those viewpoints. It should be noted that the data from which these two case studies were drawn were part of a larger study. First we describe the larger study, and then go on to introduce the narrative network approach that we applied to the selected exemplar data.

The data analyzed in this work were drawn from a larger mixed-method study of processes surrounding IT at UniHospital. Data were collected from February through May of 2008. This work was conducted in two phases. In the first phase, seven interviews were conducted with senior researchers and department heads. These interviews typically lasted around 60 minutes with none lasting for more than two hours nor less than 45 minutes. During this phase of the research, a variety of topics were covered including general feelings about Health IT, policies and strategies for adopting new technologies, handling of research and clinical data, feelings about imminent and long-term changes at UniHospital, and experiences at other institutions.

In the second phase, we conducted over 150 hours of observation and 32 formal interviews at 7 sites within UniHospital. Sites were identified by taking an initial list of a wide variety of clinical and research units and narrowing it based on interest and availability from the particular departments. Sites of inquiry included two Intensive Care Units (ICU), two units dedicated to outpatient care only (one primary and urgent care, one geriatric medicine), two units holding a mixed mission of research and clinical care (one focused on general medicine, one specifically on cancer), and the Information Services unit that serves the entire hospital. These units represent a wide variety of sizes, with the Neonatal ICU being one of the smallest units in the

hospital with only a few rooms and the Cancer Center at the other end of the spectrum housed in its own multi-story building. They also have varied missions and processes as appropriate for the patient populations they serve.

At each site, as appropriate to the work at that site, information was collected through participant and non-participant observation, field notes, informal interviews with both clinical and non-clinical staff, and artifact collection. These artifacts included workflow diagrams created in anticipation of a new EMR system planned to be rolled out approximately 18 months after the study period, the results of a patient satisfaction survey administered to a sampling of patients, floor plans and other physical plant plans, forms and documentation for a variety of purposes, brochures for services within and outside of the hospital, web presences of every department, and other associated materials. Formal interviews were recorded when acceptable to the participants and transcribed (all but two).

From the larger data set described above, two case studies were chosen for narrative network analysis: patient scheduling and chart delivery. These two cases were central to the next phase of development of the comprehensive EMR solution. Furthermore, the workflow models that had been developed around these processes were identified in our initial analysis of our empirical data as lacking. Finally, these two exemplars provide an abundance of alternative arrangements of actions and technologies.

A narrative network is not a conceptual structure, but rather “a method for representing and visualizing patterns of technology in use” [8]. What narrative networks provide is a resource for understanding the complexities of organizational processes that accommodates different points of view without attempting to create a “view from nowhere” that might be common in the construction of workflow diagrams. Likewise, Berg and Bowker describe the medical record as constituting “multiple histories” [1]. Seeing organizational forms as collections of stories, narrative networks are ways of understanding the structures of and relationships between stories. Narrative networks themselves are graph structures. The nodes in the network are narrative fragments, involving two or more actants and an action that goes on between them (*e.g.,* "The administrator edits the Excel document," "I pick up the phone," "The runner checks the pigeonholes"). The links between these fragments describe sequential relationships that are the foundation of coherence in any narrative. It is this coherence that qualifies these fragments to be part of a narrative, as opposed to a chronicle or a set of disconnected events [8, 36, 37, 38].

Development of Narrative Networks

Development of narrative networks, rather than more common guidelines or workflow models, enables a more flexible and nuanced understanding of complex organizational processes *in situ*. By focusing on narrative, they draw attention to the stories

about organizational work that processes set out. By focusing on networks, they highlight the importance of how these narratives – and narrative fragments – interact and connect.

A description of the hierarchy of elements making up a narrative network can be accompanied usefully by a molecular metaphor for organizations [8, 39]:

- **Actants** can be human (patients, nurses, etc.) or non-human (hardware, software, etc.) and make up the smallest level of the narrative network, like atoms or elements.
- **Narrative Fragments**, like molecules, can fit into many different narratives and include a combination of actants and actors (*e.g.,* "the patient picked up the phone", "the nurse viewed the chart").
- **Narratives** are particular sequences of coherent functional events with a logical sequence (beginning, middle, and end) that is dependent upon the view of the "narrator" (*e.g.,"*The patient picked up the phone and dialed the hospital appointment line in order to make an appointment with her primary care physician."). Continuing our metaphor, like polymers or proteins, narratives have some sort of unity of purpose or overall coherence.
- **Narrative Networks** include actants and actions coupled into both potential and actual fragments, which can be connected in a variety of ways into both potential and actual narratives. Functionally, this graph view shows all of the narrative fragments and any connections between them, summarizing both the sequential connections that make up parts of a narrative and those that could be used to create a new narrative.

Mapping out the narrative network associated with a particular account of an organizational routine reveals the space of alternatives within which it is embedded (such as alternate forms of communication, different potential sequences of action, or delegations of actions to different individuals, systems, or artifacts). Mapping out the narrative networks associated with multiple particular accounts further demonstrates how these stories connects to one another.

Narrative networks may have different degrees of formality; they need not, for instance, notate anything about the frequency of particular sequences of action, although they can be extended to do so. Scope and perspective are always important, though; a narrative network may combine multiple points of view, but a consciousness of the points of view represented or included is an important consideration in developing or using the network. There are four basic steps one must take to construct a narrative network based on fieldwork and analysis, regardless of the degree of formality. We here walk through those four steps using the example of constructing our chart handling narrative network [8].

Choose a focal phenomenon and define its boundary

The storyline of the narrative must be bound in some way. Pentland and Feldman reference Burke's five elements that define the edges of such a storyline: scene, act, agent, agency, and purpose [40]. Clearly, the scene is of fundamental importance to bounding the ways in which a chart might be request and delivered. We initially bound our narrative to within UniHospital, matching the overall goal of replicating and adjusting this process in the new system design across the entire organization. However, as we began to construct our network, it became clear that different clinical centers enact different organizational patterns around these activities. Thus, in developing each network, we further constrained our scene to individual departments. By constructing multiple narrative networks in this way, the variability that is core to these processes and patterns within the different sub-organizations of the larger organization become much more clear. Similarly the agents and actors are highly varied among these processes and departments. What ties these narratives together, however, is the purpose. All of the actors within UniHospital have some shared goals, largely around delivery of high quality patient care. The ways in which these shared goals become articulated into subgoals, such as ensuring up to date patient information or scheduling patients expediently for the services they require, however are highly flexible, again highlighting the need for a dynamic view of the work.

Choose a point of view

All narratives—indeed, all representations of work—inherently have some point of view as part of their construction. The workflow diagrams being constructed at UniHospital during the time of our study appear to be omniscient on the surface. However, they are necessarily and intentionally abstract and leave out the details of individual viewpoints. During our fieldwork, the data we collected by observing work practices and technology use were also necessarily partial and informed by the viewpoints of the specific study participants. In constructing a narrative network, one can use only a single viewpoint or merge those of multiple people. Likewise, the viewpoint of narratives can be past, present, or forward looking. In the case of workflows at UniHospital, the narratives they constructed were nearly all prescriptive, a model for how the work should be done, albeit grounded in understanding of how the work currently happens. In the construction of our narrative networks, however, we analyzed detailed field notes on how the work has happened in the past and constructed our network based primarily on the view of the staff patient-treating departments as well as the records management service on site at UniHospital.

Constructing narrative networks requires that a point of view (or multiple points of view) be chosen explicitly and articulated, revealing then inherently whose viewpoints are being obscured. For example, by constructing the particular narrative network

we developed based on empirical data of the chart handling process we include the work of "runners" in the chart handling process. Thus, it became important to understand both their role from the point of view of clinicians and from the point of view of those working in records management.

"I don't know what [the runner] does, but he does deliver different charts to different clinics, and then he's supported to run back there [to records management] to see if there's new requests that he needs to go deliver." – nursing manager in outpatient clinic

"[There are] no return requests on charts… [each runner will] only pick up the ones that you see….Save charts up, and put them all out at once." – chart runner

At the same time, this approach to analysis of our data leaves out the viewpoints of those at the offsite data management service. The actors at UniHospital interface rarely with these individuals. Furthermore, by choosing to Recognizing whose viewpoints are privileged and whose are excluded is an important step in narrative network analysis and one that affords a more accurate understanding than the omniscient-appearing workflow models with no recognizable viewpoint.

Collect Narratives and Code Fragments

One can collect empirical data from the chosen viewpoints and build the narrative networks as the data are collected. Another option, however, and the one we used in this work, is to analyze empirical data gathered as part of a larger study. Both approaches, however, have the inherent challenge of mapping the storyline an individual interview participant follows or that can be observed in the field onto the interconnected, developing map of the narrative network. "People are unaware of the connections they are making, and therefore, are unaware of certain actions and actants" [8]. For example, describing a chart request, a nurse might state simply that he walked to the computer and ordered the chart, thereby skipping important elements such as logging in to the system, checking the progress of the request, checking the clinic's pigeonholes for the chart already having been delivered, and so on. Another informant might describe some technological details but not other and leave out some of the process steps one can observe in practice, such as a nurse informaticist in the SICU describing the current record-keeping system:

"[The current system] is DOS based. When you are in the program, you can hot key…over to your Intranet, but you can't launch into the Internet from the application…Right now we are very paper heavy. Every report put into TDS spits out a printout at the nurse's station, and they print their worksheets twice a day…. Paper paper paper… once we get to the new system, it will be real time…[and]… more interactive."

A trauma research associate in the same department described the record-keeping process in terms of medical terminology and best practices rather than in terms of the technologies and media:

"We're required to keep written records of findings, which includes a daily log of patients in the SICU, and once a patient leaves, we update the status of the patient using the computer systems… We record if the patient is on a ventilator. We record if their nutrition goals are met. We record if their VAP bundle was met. We record if weanable to come off the ventilator. We record lab results…."

Another researcher in the same ward described the same documentation processes with regard to the educational agenda and the various actors in the documentation process:

"Some doctors use the PDA… to take pictures of their interdisciplinary notes after they are written out to protect themselves… During rounds, each resident physician has one or two patients, which they are responsible for, and as they go from bed to bed, the resident in charge of this particular patient will give his input or diagnosis…so the attending is making sure they don't screw up. So, basically there is another resident doctor who is using the COW [Computer on Wheels] to input everything that the attending doctor puts down on the interdisciplinary notes."

Although these individuals are talking about the same records, and indeed the same record-keeping practices, their viewpoints make these discussions substantially different. Informants cannot be expected to make these connections nor document these details, many of which are tacit knowledge opaque to the people being asked about them. Narrative network analysis provides a way to graphically view these connections and supports researchers in understanding the ways in which these various viewpoints do and could relate.

Relate Nodes by Sequence

Narratives are inherently sequential. That is to say, when telling a story, one describes what happens first and then what happens next. The network emerges from the connections between sub-nodes as parts of different stories. As such, one can closely inspect any individual narrative, or even a sub-part that may have minimal or no connections to the outside world, for details. At the same time, viewing the entire narrative together can reveal information about which parts of the routines are present most frequently. In our case, by using a unique line for each informant who identified a particular pathway, we were able to see as the lines thickened those parts of the narrative network that were more frequently represented in our data without obstructing the view of those pathways that were seen less frequently. In constructing the formalized final visualization, we used two types of arrows, a thicker version for more frequent paths and a thinner version for more variable

paths. Beyond the kinds of empirical and analytical uses to which we put narrative networks, with a sufficiently large dataset and the right research questions and techniques, narrative networks could also be treated as valued, directed graphs [8, 41] or as first-order Markov models [8, 42]. Ultimately, however, the degree of formalism employed in the construction and representation of these networks is largely dependent upon the use to which they will be put. In our case, that use was to highlight variation amongst routines, particularly those that had been articulated in workflow diagrams already, and to suggest areas in which the processes and technological solutions currently in development may be lacking.

INTRODUCING TWO CASE STUDIES: PATIENT SCHEDULING AND CHART DELIVERY

The examples of chart delivery and scheduling usefully illustrate organizational structures and the relationships that are enacted through work processes—in other words, the relationship between the performative and ostensive components of work Specifically, this relationship is one in which the ostensive provides a resource upon which each actor may draw to determine and perform a set of actions. Broader patterns of organizational life (the smooth flow of work, the effective and efficient delivery of care, the status hierarchy and power dynamics of clinical life, and so on) are maintained and reproduced in just that relationship. Focusing purely on the abstract account as detailed in formalized representations would obscure the complex choreography of work; focusing purely on the lived detail of the work would fail to acknowledge the ways in which they enact broader organizational patterns.

Patient Scheduling

On the surface, scheduling patient visits may seem a rather straightforward task. A patient contacts a scheduler, either by phone or through the online contact system, the particulars of the visit are collected, and an appointment is made. However, there are complexities involved in even this simple task. A narrative network of scheduling taken from the patient's viewpoint *highlights the varying pathways into the system and the communications media present in those pathways* (see Figure 2). In this case, the media present are an online system and a phone-based system and associated call center. This network also highlights the substantial continued involvement of the call center in the scheduling process despite the presence of an online system. Examination of this network can demonstrate the challenges of administrators hoping to automate much of the patient scheduling in a similar move to what the airline and hotel industries might face. In addition to the complexity of what is

happening on the patients' side, this negotiation is rife with complexities within the clinical organization. A particularly illustrative example of these complexities is the range of ways in which clinicians and office managers negotiate their work schedules and in turn make those schedules known and codified within the patient scheduling system. One nursing manager described this process at her outpatient clinic:

"…when a doctor needs to go somewhere, they need to send me a form saying, 'I'm requesting this day off….' Then I would send a request to the call center to block the schedule so we don't put the patient in those days. Then after that, we put it into our monthly schedule, because I do my weekly schedule based on who's here and which staff would work with that doctor."

This weekly schedule is maintained in Excel and stored on a shared drive in the clinic; however, although the nursing manager is the primary coordinator, this electronic copy is not created by her:

"Well, someone makes it for me. I don't know how to use Excel. Someone makes it, and someone enters it. I'm kind of like the gatekeeper when they need time off. I would tell the call center, 'block these dates because they're going to be out' and then I'll tell the other girl who is keeping track of this 'enter this and provide a schedule for me.'"

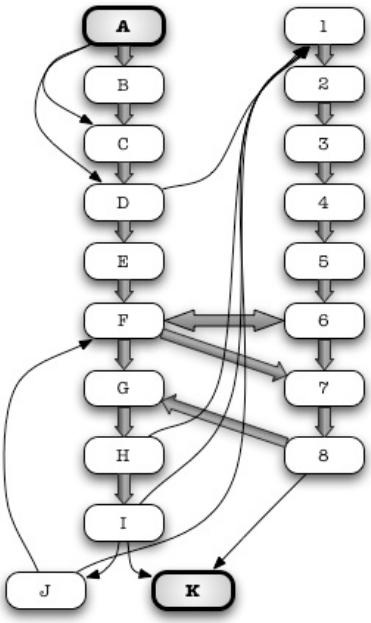
NARRATIVE FRAGMENTS "I schedule an appointment on the Web"	NARRATIVE NETWORK	NARRATIVE FRAGMENTS "I schedule an appointment by phone"
A. I turn on the computer B. The computer connects to the network C. I launch the Web Browser D. I log in to RelayHealth E. I select three options for potential appointment times F. Scheduler consults my available times and those available to the physician G. Scheduler enters an appointment and requests chart delivery H. I receive email alerting me to a response to my email in RelayHealth I. I read response in RelayHealth J. I reply with a request for a different appointment **K. I confirm the appointment in my calendar**		1. I pick up the phone 2. I call the main hospital scheduling line 3. I follow a series of prompts to reach the appropriate scheduler 4. Staff member answers the phone 5. Staff member routes me to appropriate scheduler 6. I tell the scheduler my appointment needs 7. Scheduler suggests appointment times 8. I select my appointment

Figure 2: Narrative Network of patient scheduling process as viewed primarily from the patient's vantage point. A narrative fragment with only outbound linkages can arguably be seen to be a starting point and is highlighted (A). Likewise, a narrative fragment with only inbound linkages (such as K) can be seen as an ending point of the overall narrative and is also highlighted. Thickened lines indicate those paths observed most frequently in our data and highlight more common processes but still allow for the viewing of alternate paths. NN allow for visual representations then of both what is and what might be.

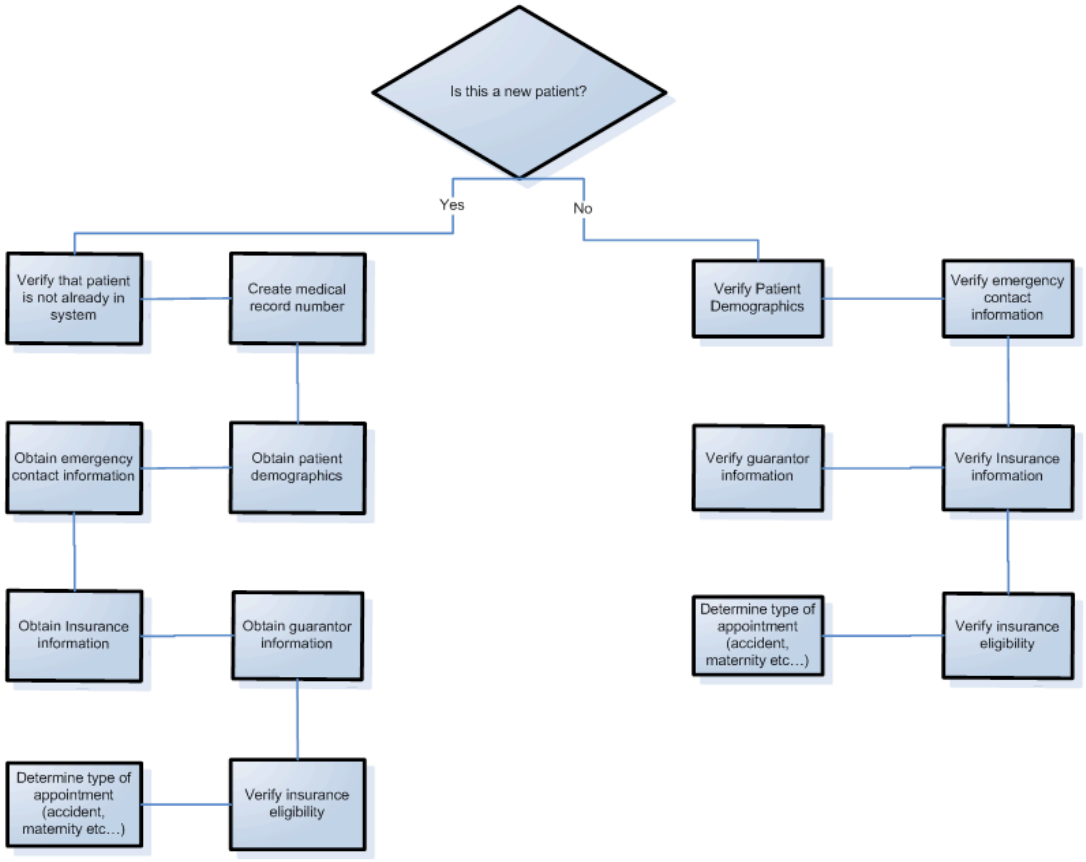


Figure 3: Workflow model developed by UniHospital Information Services to document the call center process.

One might imagine given this evidence that the solution would be simply to provide either clinicians or office managers (or indeed, both) the ability to indicate time away directly into the patient scheduling system. The new comprehensive EMR system planned at the time of our study has the capabilities to support just such a solution. This view neglects, however, that office managers currently have access to the patient scheduling systems but circumvent these, an issue that arises prominently in a network view of these practices: They can block clinicians' times themselves, just as they can schedule patients for follow-up care when those patients are physically present for an initial visit; they do not, however, take advantage of this access due to a variety of regulatory and organizational processes that are unlikely to disappear with the implementation of a new system, including the need to create a paper audit trail.

"I do have access to go in and block, but the girl needs a physical piece of paper to know that it's a legit request. But I don't have the time… to go in and block the system and then go into another system to enter in: the doctor's going to be out this day and this day in the Excel table. Eventually, I can't do it all, so I choose to let them have that space."

Thus, the activities that make up clinician scheduling—request for time away, negotiation of that time away with other members of the clinical staff who are affected by this choice, notification and documentation of this time in local and shared systems, and so on—are dynamically included, excluded, and combined in various ways throughout the performance of this overall task, depending upon the individual human actors involved, the equipment and systems to which they have access, and the wide variety of narratives they can construct using different combinations of actors and actions. A narrative network highlights efficiently a large number of contingencies and alternate pathways in these accounts.

Records Management and Chart Delivery

The data from our fieldwork and subsequent construction of narrative networks based on those data (such as the chart delivery network depicted in Figure 4) revealed important areas of concern for process management and technological innovation. Requesting, receiving, reviewing, and returning medical charts are fundamental and time-consuming activities throughout UniHospital. The challenges associated with the update and movement of these paper-based records is perhaps the biggest motivation for a move to an EMR. The prototypical process of receiving medical charts is fairly similar across the medical center with charts being requested and received throughout the day. Requests are often made by a nurse manager or records specialist on the behalf of others. A nurse or records specialist typically makes a request in an online system, which is received in the Medical Records department. Before a chart can be checked out and placed in transit, a staff member in the records facility must notice the physical request's arrival on the *Spindle*, a large printer connected to the online system used for creating paper, archivable versions of the request generated online. A commercial software package is used for checking charts in and out. However, only a very limited set of people can access this system to track the movement of charts, and many departments do not have views into this information. Once a chart is marked as "in transit" in the software, it can take anywhere from minutes to several hours for it to arrive at its destination. Chart delivery workers called "runners" watch the case of "pigeonholes with outgoing charts and make a tacit determination of when enough charts are ready to be delivered to begin the delivery process throughout the main medical center campus. Eventually, a runner brings the chart to the department requesting it.

The "standard" practice, however, glosses over many of the variations that are represented within the network. For example, one nurse in geriatric medicine described frequently needing charts that were located in other areas of the medical center (*e.g.,* urology), because so many geriatric patients are seen by multiple providers in a short span of time. At times, this situation is the result of the department holding the chart simply because they are backed up in process of updating records and are holding on to charts for several days after an appointment. This situation can be frustrating for the department in need of the chart, and it is this type of situation that the turn to making digital records available simultaneously to multiple departments is intended to

NARRATIVE FRAGMENTS "I request a patient chart using the electronic system"	NARRATIVE FRAGMENTS "I request a chart from another department"	NARRATIVE FRAGMENTS "I request a chart using the phone"
A. The patient schedules an appointment B. The call center enters a message in RelayHealth "Chart Requested" C. I turn on the computer D. I launch RelayHealth E. I review a message in RelayHealth F. I see "Chart Requested" G. I write on paper the chart number requested H. I log into SoftMed for a "chart check" I. I look up the chart number requested J. I see the chart is here K. I see the chart is in Medical Records L. I see the chart is elsewhere M. I log into Signature N.. I enter the Medical Record number O. I enter a message noting when and why I need the chart P. An agent in Medical Records sees the request Q. An agent in Medical Records pulls the chart and places it in the outbound bin R. An agent in Medical Records marks the chart as checked out in SoftMed S. A runner delivers the chart to our department **T. A nurse checks the delivered charts for the one needed**	a. An agent in Medical Records prints a slip of paper showing where the chart is and places it in the outbound bin b. A runner delivers the message to our department c. I ask the runner to retrieve the chart d. I enter a message requesting delivery from the department holding the chart e. I call the department with the chart f. A staff member in the department with the chart answers the phone g. I provide the patient's name and request the chart h. The staff member agrees to provide the chart i. A runner from the department delivers the chart j. A runner from Medical Records picks up the chart at the other department k. The staff member refuses the request for release of the chart l. Someone from the delivering department logs into SoftMed and notes the delivery	1. I note a need for the chart urgently 2. I call Medical Records 3. A Medical Records worker answers the phone 4. I provide the Medical Records number 5. I describe the urgent nature of the request 6. I ask where the chart is currently 7. The Medical Records worker checks SoftMed 8. The Medical Records worker tells me the location of the chart 9. I ask the Medical Records worker for the chart 10. The Medical Records worker enters a request in Signature 11. The Medical Records worker asks a runner to pick up and deliver the chart

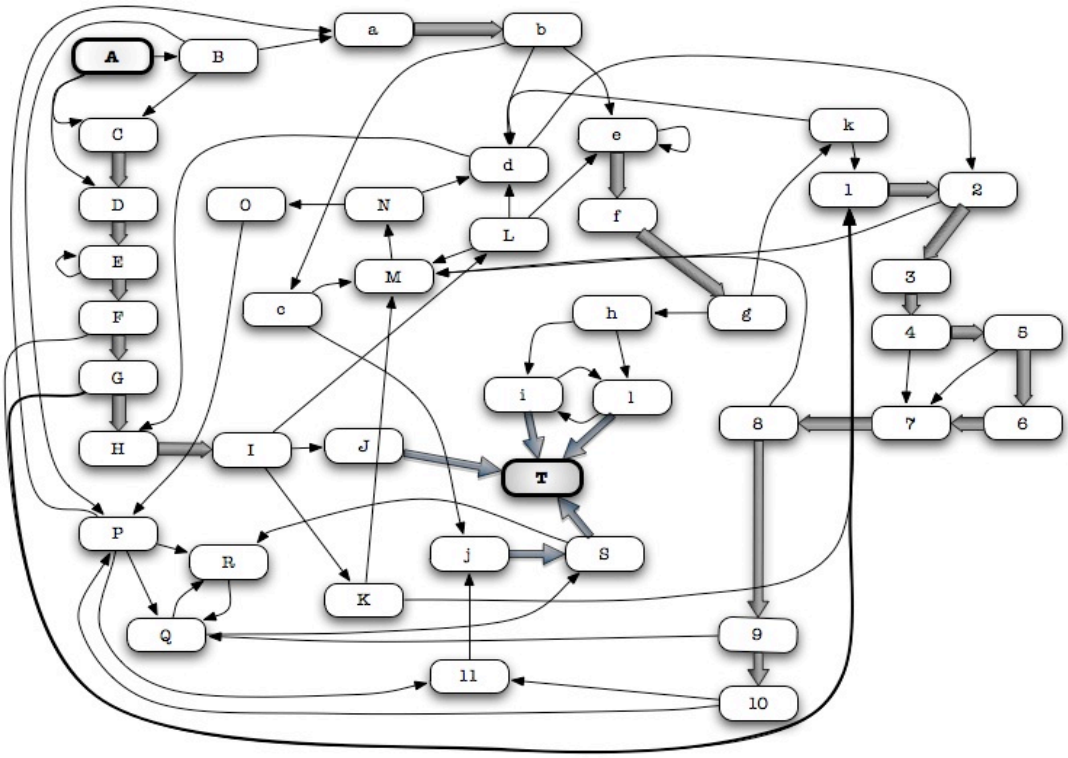


Figure 4: Narrative Network of chart request and delivery process from nursing manager viewpoint. A narrative fragment with only outbound linkages (A) is highlighted. A narrative fragment with only inbound linkages (T) is also highlighted. More frequently traveled narratives have thicker linkages.

prevent. However, the drive to efficiency can miss an important point about the physical chart; its ability to be in only one place at a time essentially provides a lock on the data. Thus, if a record needs to be updated in Urology, and the nurses there have not yet had time to update it, someone in Geriatrics cannot access the—currently incomplete and inaccurate—record without someone in Urology knowing. When the nurse in Geriatrics calls Urology for the chart, part of the negotiation over the physical artifact is a discussion of recent and upcoming patient care activities and the health status of the patient. Thus, the conversations that happen around delivery of the records are often more complex and more clinically relevant than they might at first appear.

Having introduced the two exemplar activities of chart handling and patient scheduling, we will use these two case studies to motivate a reconsideration of organizational processes as the basis for technological interventions in cases such as ours. Our goal is to get beyond a view of processes as step-by-step procedures and to recognize that flexibility, openness, and perspective are not just important to incorporate, but are the *source* of the effectiveness of these processes and routines. Finally, we demonstrate through examples drawn from our fieldwork that narrative networks can be used to visualize complex processes more appropriately in many cases than workflow models, no matter how carefully constructed and flexible the workflow models are.

NARRATIVE NETWORKS IN HEALTH IT

Designing and developing large-scale Health IT systems are complex activities in much the same way that implementing process or technology changes in any large organization are challenging. The rhetoric of business process reengineering and automation has reached all parts of industry and fits well into the overall culture of evidence-based medicine in the United States and other Western industrialized nations [43]. However, even now with the vast research into organizational routines, they may still be misunderstood as rigid and rules-based, mundane accounts that can be (and largely are) explicitly documented and stored [35].

Instead, organizational routines are "live routines" [35] in that they are numerous and generative, with each enactment giving rise to new performances and new patterns of action [9]. This inherent power towards innovation can be a benefit to organizations willing and able to capitalize on it, but at UniHospital and in healthcare systems more broadly, the regulatory environment and focus on evidence-based practices are likely to keep these issues in tension. Without full automation—which indeed some have suggested [44]—these variations in performances cannot be totally destroyed and so must be recognized and addressed. Faced with this variation in routine *and* the requirement to have high standards of quality patient care, what then is a medical center attempting to implement large-scale systems to do?

"A Broader Range of Possibilities"

Based in large part on the last three decades of research and practical work in computer supported cooperative work (CSCW) and organizational systems, hospitals and other major healthcare systems have begun to make use of workflow methods and

systems (*e.g,* [45]). In keeping with these best practices, the leadership at UniHospital employed this same approach to model processes in preparation for the new EMR system, developing myriad complex, branching workflow diagrams. These diagrams provide a detailed sequence of events for any task involving an information system with patient care as a central organizing theme.

On the surface, these workflows generally match the organizational culture of medical systems. They appropriately represent a system in which, highly trained individuals employ precise evidence-based practices to deliver interventions with the overarching goal of high quality patient care. In seeking to legitimize all aspects of their work, both clinical and non-clinical staff have over the years developed elaborate coding schemes to account for how and when they spend their time, including but not limited to nursing codes that include detailed instructions and timing for "providing hope" [1]. These codes and the precision with which they are generally executed indicate an overall culture that privileges precision and accountability.

Despite all of this intense structuring and accounting, however, another core theme runs through healthcare, again associated with the notion that patient care is paramount: professional autonomy. It is important to remember that medical providers take oaths swearing to protect their patients above all else, oaths that give them a substantial amount of moral and professional independence from these same evidence-based practices they help to develop. At times, this professional autonomy affords clinicians the notable privilege of standing by their own individual ethics over those of their patients (*e.g.,* treating a patient who has refused treatment but will die without it, refusing to perform an abortion on a patient requesting it, etc.). Most of the time, however, this autonomy manifests in much less remarkable ways, such as in an individual's choices about keeping records or scheduling days away from the office.

"I've been a nurse for 16 years, and this chart I made on this card works the best for me because of the way my mind works. I do not like being told how to record my patient's information. I need flexibility because I know how I think and work."

The flow sheet in the ICU, which the nurse in the previous quotation refuses to use, makes a particularly compelling example of an information artifact designed to "link several histories by mapping them on a similar x-axis" [1]. However, these histories are individually contained and cannot provide the nuanced vision of the actual work of charting in an ICU—hence, the nurse's resistance—much less the hospital overall. Likewise, the workflows designed to model current charting practices suffer from an attempt to draw together multiple histories in a document that still leaves them largely sequential and self-contained. The "joint-history" [1] or shared narrative [9] of how these values inter-related and who the individuals in the organization are who enacted them are not self-evident.

A narrative network, like a workflow diagram, "depicts sequences of events, but instead of showing one version of a process (with decision points that introduce branches and loops), it can display a broader range of possibilities" [8]. Clinician autonomy and professional identity necessitate consideration of this broader range of possibilities.

For example, let us take the patient transfer process described by Abraham and Reddy [46]. In their findings, they note that departments transferring patients might sometimes "hide the bed" that has been freed up by a patient transfer or discharge. This notion of hiding emerges from the department whose job it is to facilitate patient placement and who would like to know immediately when a bed is "free." From the perspective of the departments said to be doing the hiding, however, the delay in notification enables the unit "to postpone the work involved in preparing for transfers coming into the unit," particularly around shift change, a time when staff might feel overwhelmed [46]. Integrated systems that automatically notify the scheduling units when beds become available in treating units disrupt the ability for people to delay work intentionally, which they see as part of their autonomous professional ability to best treat patients but that is largely invisible to workflow describing the ways in which patient transferring should happen most efficiently. From the perspective of one department, the delay appears as inefficiency, but from the perspective of the receiving department, the delay is necessary to provide quality care. A narrative network approach allows representation of these different viewpoints.

This tension surrounding a means of depicting and enacting optimal efficiency in hospital processes around patient transfer mirrors findings in our field data around the delivery and checking in of patient charts described in our records management example above. According to a workflow perspective, a chart's arrival at a particular ward mirrors its being "checked out" or "locked" in a source control/database model of records management. This lock appears to be instantaneous in an integrated workflow view of the EMR. However, this singular view neglects the activities taking place in the Records Management (RM) facility. Currently, a manager in RM must notice the order, act on it, and then place the appropriate chart in an outgoing bin to be delivered. Records older than 9 years must be requested from a third party offsite, and their delivery incurs a charge to the requesting department from the third party storage service passed through RM. By some tacit understanding of a threshold for quantity of records or substantial time since the last delivery, the chart "runners" then pick up outgoing charts and take them to the requesting departments. Typically, although not always, RM personnel check the charts for accuracy and completeness. This process of piling, waiting, and delivering records sets expectations on the receiving end about when charts must be requested, the amount of time it takes to receive them, and the safety and accuracy checks that are done on them.

Generative Routines

Organizational routines are "generative" and "produce recognizable, repetitive patterns of independent actions carried out by multiple actors" [9, 30]. The EMR implementation at UniHospital, however, with its emphasis on workflows and the artifacts of medical records does not view these systems as generative but rather focuses on the artifacts and systems as the output of the design process. The generation of these artifacts, though representative of a strong tendency in the organization to recognize and understand the importance of the details of the work routine, results only in production of symbolic artifacts. These artifacts are mere representations of the organizational routines present—the map in the phrasing "the map is not the terrain" [41]. However, as Pentland and Feldman [9] note, the issue is much deeper than the differences between map and terrain. This metaphor implicates the organizational routine itself—the terrain—to be fixed and solid. "Because routines are generative systems, they are not like 'terrain'"" [9].

What do we mean then to say that organizational routines are generative, and in particular that the routines we observed at UniHospital are? Participants can introduce variety into narrative networks in two primary ways: by using alternative means for completing a particular task within that functional event and by creating alternative sequences of events. Returning to the examples laid out earlier, individuals use both these methods to introduce variety into their routines at UniHospital.

Within individual functional events, staff can perform their tasks in any variety of ways. Returning to our example of handling chart requests, in some units, an office manager has access to the chart tracking system and can locate a chart without communicating with anyone in Records Management. In those units, the office manager sometimes performs this task and other times contacts someone in Records management (via phone, email, fax, or "runner"), and that person interacts directly with the system. Regardless of the method for entering the data in the system, a paper artifact frequently accompanies these communications to ensure legitimacy. Thus, even with implementation of new systems, this multiplicity is unlikely to disappear.

The sequences of particular events are regularly reformed and negotiated on the fly. In the case of chart management, the ordering of the chart may happen before or after other activities such as checking lab results and confirming the appointment. Likewise, updating charts with new information can happen before or after the patient leaves, a new appointment is scheduled, tests or medications are ordered, and so on. Furthermore, when these events loop back on themselves (*e.g.*, due to errors, changes in a clinician or patient's schedule, changes in disease state or prognosis), the variability intensifies. These variable routines have as much to do with practicing medicine as they do with handling logistics. The various ways in which these narratives are constructed and activities carried out are fundamental to the particular professional training that has been received by the human actors, the various resources available to them, and the uniqueness of the situation in which the clinical and non-

clinical staff, patients, and other stakeholders find themselves. Clinicians must integrate the latest evidence and guidelines into their decisions in these inherently variable situations. It is this variability, in fact, that necessitates the complex and ongoing training of clinicians and simultaneously enables such dynamic high quality care. Thus, a lack of accounting for this variability will almost certainly have real costs associated with it, including the potential for less responsive, lower quality care.

Considering Multiple Viewpoints

Narrative networks are particularly powerful in their ability to demonstrate routines from a variety of different viewpoints. These viewpoints all include in a notion of the routine at hand, some "coherency or unity of purpose" [8, 38, 42], that serves as the overall narrative. In our examples, these overall narratives include delivery and management of medical records and clinician and patient scheduling. The fragments of this narrative—multiple interrelated individual actors taking action through a variety of digital and analog systems—make up the interrelated network. The complexity of these examples, as well as other activities in UniHospital, requires analysis of the same routines from multiple viewpoints. As one nursing manager commented:

"Everything we do is interrelated, because if you need to see the process, you got to follow and see why it's taking the guys so long …to deliver the chart to the clinic… if they improve their work, we will improve… and that will improve patient care."

For example, in the workflow representation for patient check-in at one of UniHospital's outpatient clinics, calling for a chart and its delivery are seen as being in an uncomplicated direct relationship (see Figure 1). In reality, this functional event requires participation from at least three individual human actors (the requesting nurse, the records manager, and the runner who delivers the chart), each with their own perspectives on the task at hand. This example draws our attention to the varied perspectives of the individual actors and the means by which they communicate and negotiate. Using our narrative network analysis (see Figure 4) and a deep examination of the fieldwork, we can see a complex set of relationships at play, including communication between departments about ongoing patient care that has not yet been fully documented in the medical record or that may never be.

The complexities of this process are not easily dismissed with a single monolithic system built from the view of the design team, even if that design team is careful to gather input from various stakeholders. We have already seen how access to the current system did not reduce steps in the process for nursing managers who still chose to keep paper or Excel records of their own units that are separate from those of the patient scheduling center. These examples demonstrate the appropriation and continual redesign of both the processes and the technologies to handle the multiple perspectives of the organizational routines at hand. Narrative networks provide a more appropriate means of visualizing and understanding the potentials of these dynamic routines.

IMPLICATIONS FOR HEALTH IT

To oversimplify the situation, workflow modeling that is so prevalent in designing large-scale collaborative systems for healthcare, provides a view of how processes *should* occur. As an alternate view, narrative networks, provide a view of the variety of performances or narratives that *could* be generated based on recognizable patterns of organizational routines [8, 9]. A vast range of possibilities is invoked by allowing for the multiplicity of stories created through combinations and recombinations of narrative fragments. This model, though less in tune with the audit culture [48] of most hospitals, actually better matches the patient care culture in which highly trained professionals must make decisions on a regular basis that put patient health and comfort at the center above all other things, including regulation and accountability.

A traditional approach to the design and implementation of large scale HIT (*e.g.,* EMR) engenders a systems and workflow focus, one that privileges standard operating procedures, legal regulations, hospital policies, and so on. Instead, through this examination of our ethnographic data, we can see situations in which exceptional behaviors occur through a complex web of performances within organizational routines told from the stories of many different narrators with many different viewpoints. Here, then, we take an approach in which technology design and use is an "ensemble view" [49] complete with fragments that can be and are recombined at will by these individual narrators, all of whom are working with shared unity of purpose for high quality patient care, but many of whom have strongly conflicting ideas about what actions lead to that high quality patient care.

The traditional approach to the design and implementation of HIT systems puts the system itself as the ultimate end goal of the design process. This approach, however, may not be well suited for understanding and designing around the complex organizational routines of a major medical center. The traditional approach views routines as things to be modeled through workflow diagrams and other mechanisms and to then be concretized in the EMR system itself. Instead, here, we argue that narrative networks offer another perspective, one that privileges the notions of live routines and the autonomy of the individual human actors. We can use this perspective to design systems and processes that are more appropriate in terms of their recognition of routines as generative not prescriptive.

Using Narrative Networks in Practice

Pentland and Feldman [9] outline seven guidelines for designing live routines. In our work, we found their approach of using narrative networks to be a useful mechanism by which we can meet these guidelines. In this section, we outline their recommendations as well as how these guidelines apply to the design of records systems.

First, designers and decision makers must **invest in describing the ostensive aspects (*e.g.*, generalized, abstract functions) of practice and technological use**. The ostensive aspects of the routine enable participants to connect symbolic artifacts (*e.g.,* a

treatment plan) to the desired performances (*e.g.,* delivery of nausea medication and food simultaneously for patients with trouble eating). It is too easy to focus overmuch on performative aspects—generation of medical records, plans of care, and other artifacts—that do not alone provide a complete picture when considering live routines in medical care. Clinicians are highly trained, knowledgeable individuals. They work in teams (*e.g.,* a surgical team typically comprises a surgeon, residents, anesthesiologist, nurses, and more). They practice and get regular feedback and continuing education. The best clinicians often describe knowing what other team members do so well that they can dynamically and without any explicit consideration adjust to one another, like a jazz quartet jamming at the end of a set. They have a deep understanding of each others' practices and priorities that can easily be missed by an outside observer looking only for performative aspects.

Second, implementers of HIT systems must move away from their singular systems viewpoint—a view from nowhere in particular—and **consider the viewpoint of each individual participant**. As just one example from the analysis conducted here, a comparison of the visual representations in Figures 2 and 3 demonstrate both how workflows and narrative networks highlight different aspects of the same routines but also how the varying viewpoint (call center, IT system, or patient) strongly influences what is represented in the data, the analysis, and the visual representation. Consideration of the multiplicity of viewpoints is more than just holding focus groups for various types of workers (*e.g.,* physicians, nurses, and office mangers) or departments or convening standard workgroups to advise on the system design and implementation. Rather, truly considering the vast viewpoints in a diverse organization enables a new sort of awareness, one that opens the Administration and Information Services personnel to the broad space of possibilities enacted by these varied actors. This larger understanding of the variation in routines would enable hospital administrators and Information Services staff to grasp processes that are closer to both the way work is currently carried out and experienced and the ways it could be.

Third, in creating representations of the organizational routines—which must still occur when implementing systems of this size—designers must **consider the relationships between specific observed actions and possible abstract patterns**. The narrative network creates a space in which the various ways of moving from one event to another can be performed. For example, when considering chart delivery, part of our network analysis included considerations of what routines might begin to erode with the use of an EMR. Specifically, we noted places in which communication and coordination impacting patient care would be reduced, because the logistics of tracking down and retrieving a paper chart would no longer be present. Perhaps even more importantly, narrative networks then create a means for discussing whether and how these variations might matter. In those case in which the variations do make a substantial difference, individuals can then support and encourage them when they are beneficial while developing interventions to handle situations in which they can be detrimental.

Fourth, in creating and examining narrative networks, **common pathways must be examined as important sites for intervention or reinforcement**. These "ruts in the road" [9] may be visually represented as thick lines or may simply be paths that are represented frequently in the empirical data. They represent pathways that are already preferred by the actors in the system and together comprise the most common and likely most stable organizational routines. These paths can indicate areas for training or greater communication so that desirable pathways can be encouraged over the status quo. In particular, when new systems will require the use of new pathways, a thorough examination of these ruts can help identify barriers to adoption. In our analysis, we surfaced many pathways that would be greatly impacted by exchange for an electronic system. For example, pharmacists often print documentation and discuss it with one another or at the bedside of the patient. Our analysis indicated the potential for new routines to emerge around a fully electronic system in which printing is either discouraged or not allowed at all that would change the way in which these discussions occur, most notably in terms of place (at the computer rather than at the bedside).

Fifth**, decision points are likely locations for innovative problem solving and exertion of autonomy**. The narrative network model encourages a way of framing organizational routines such that the decision points commonly represented in a workflow become design points at which individual actors are innovating in the moment. The clinicians themselves have a largely generative, improvisational mindset, making use of their years of training and knowledge about medicine and the hospital to treat their patients. Thus, they regularly make significant (and less significant) decisions about how their work gets done, and in fact whether and how to use decision support tools built into HIT systems. As they appropriate or ignore particular aspects of these systems, they become designers of the systems themselves. A consideration, then, that these daily decisions are in fact design decisions enables a new way to think about the overall design and implementation of the EMR generally.

Sixth, stakeholders must **identify points or narrative fragments where alternative pathways would be damaging to the organization**. We must recognize the inherent tension between on the one hand, the autonomy and improvisational nature of clinicians and on the other hand, the need for regulation and protection of patient safety. These two goals will always be ultimately linked in some amount of tension. Thus, in designing HIT systems, decision makers should identify and lock the particular events that are fundamental to the goals of regulation and patient safety. For example, use of triggers and control points in prescribing systems can identify or prevent misuse of controlled narcotics.

Finally, organizational leaders, systems designers and implementers, and researchers should be **prepared for continual engagement to accommodate change and new routines**. Too often, the processes surrounding deployment of information systems inherently focus on the design and implementation of these systems, often going only so far as training and installation.

Follow-through for years or even decades after the installation of a new system can be challenging. For example, at UniHospital, a consulting organization with significant expertise in the EMR package being used has been contracted to provide substantial support during design, development, deployment, and training. The budget to include these consultants long-term, however, is not available, and consultancies tend to have limited expertise in this kind of long-term engagement. There exists then a potential gap between the identification of organizational routines and designing for or around them and evaluating the long-term changes in the environment and in these routines. Specifically, if full automation will not completely eliminate a routine, hospital leadership must be prepared to support changing that routine as needed alongside the deployment of new technologies. Furthermore, quality improvement measures must be identified to support attending to the emergence of new patterns in the narratives and consequences of the adoption and use of new systems and processes.

CONCLUSION

In this work, we have used narrative networks to understand our ethnographic data, revealing as we did the myriad inter-related segments of stories about how work is and can be done at UniHospital. This approach enables new forms of reasoning about medical routines and can help both researchers and practitioners alike to interpret and to represent these routines in the process of their own work.

There is little doubt that the organizational and technological processes inherent to medical care are complex and can be problematic in a variety of ways. Moving to electronic medical records has been touted as a panacea for the challenges of the healthcare system. However, adoption is slow, and even in those situations in which new streamlined systems have been introduced, the expected benefits to health outcomes have often not been realized.

The gap between expectations and final outcomes has been attributed in large part to two complementary issues. First, hospitals often lack understanding of their work practices prior to the design and implementation process. Thus, medical centers have begun taking a traditional user-centered design approach: holding focus groups, performing time and motion studies, preparing workflows, and iteratively designing systems. These practices are important and necessary to designing and developing usable systems.

Second, although we have found narrative networks useful for understanding our data, we do not recommend removal of these more traditional practices entirely. Rather, we note "the effects of introducing new technologies…can only be determined *in use*" [4]. It is this second issue that reveals the complexity of the potentials of the socio-technical systems in place now and in the future. Use of narrative networks enables us to view "organizational routines as modular, recombinable fragments" [8], which Health IT systems must fit. Thus, we recommend use of narrative networks as a means for analyzing and visualizing

organizational routines in concert with more traditional requirements engineering, workflow modeling, and quality improvement outcomes measurement. This type of analysis can support a deeper and more nuanced understanding of how and why certain routines continue to exist, change, or stop entirely. At the same time, it can illuminate areas in which adoption may be slow, more training or communication may be needed, and routines preferred by the leadership are subverted by routines preferred by the staff.

Finally, although this paper explored the use of narrative networks in a hospital environment, the narrative network approach can also be useful in other environments. Narrative networks can be useful in other complex, large-scale collaborative health systems with a diversity of actors and a multitude of interwoven processes.

AUTHORS' CONTRIBUTIONS

Gillian R. Hayes, corresponding author. Dr. Hayes supervised the data collection in the study, conducted the initial analysis, and led the writing of the manuscript.

Charlotte P. Lee. Dr. Lee contributed substantially to the data analysis and writing of the manuscript.

Paul Dourish. Dr. Dourish contributed substantially to the data analysis and writing of the manuscript.

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CONFLICT OF INTEREST STATEMENT

None of the authors have any financial or other conflict of interest with this work.

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