Foraging for Information in the EHR: The Search for Adherence Related Information by Mental Health Clinicians

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Abstract

In this project we sought to qualitatively describe clinician's search for information related to the complex construct of adherence. Nineteen think aloud observations and semi-structured interviews were conducted with mental health providers as they prepared for a patient visit. The transcripts were coded according to constructs from information foraging theory (information goal, patch, scent, enrichment, and opportunity cost). The search strategies uncovered were complicated: provider's searches were sometimes multi-staged (e.g. a search of the EHR led to further enquiry when interviewing the patient), and involved multiple 'patches' (i.e. data from the EHR, the patient and other providers were all sought out). In addition, some information that providers considered relevant to understand adherence related questions was non-obvious (e.g. the absence of specific information was considered a useful cue). Providers' information search strategies for complex constructs are at times non-intuitive; implications for the design of EHR summarization tools are discussed.

Introduction

Clinicians spend significant time and energy searching the Electronic Health Record (EHR)[1]. They perform these searches to address clinical questions, and to integrate information into a coherent mental picture of their patient's status [2]. Our ultimate goal is to develop an EHR summarization tool that collects information related to a given clinical question and provides an integrated display. We hypothesize that such a tool would minimizing the time and cognitive resources required of help clinicians to locate and make sense of information relevant to the question at hand.

In service of this larger goal, the purpose of this project was to characterize providers' information needs and search strategies related to a common, but complex clinical question: is this patient adherent? Specifically, this study focused on the information search of mental health clinicians as they addressed questions related to adherence of their patients with Post-Traumatic Stress Disorder (PTSD). PTSD is a chronic mental health problem that is frequently co-morbid with conditions such as substance abuse and depression [3], and in which adherence to recommended treatment and self-care is critically important [4,5]. We chose this use case because it is ideal for exploring clinicians' search regarding adherence: the chronic and changeable nature of PTSD requires clinicians to repeatedly search the EHR in order to assess their patient's adherence to recommendations and response to therapy.

Prior Studies Examining EHR Usage

The goal of this study was to examine how clinicians use the EHR to answer clinical questions in a real-world setting. This goal requires an in-depth exploration of both how clinicians frame their questions, and how the EHR is used. Our approach is in line with prior work, which has observed clinicians as they use the EHR [6, 7, 8, 9] .The novel component of this work is our focus on clinician's search process as they use the EHR to address their information needs, based on their mental model of the information space. We believe that this approach can derive important implications for EHR design.

Information Foraging Theory

In this study, we used the constructs of Information Foraging theory (IFT) as a conceptual framework. IFT has been used to describe and predict individuals' search behaviors on the internet [10], and in bibliographic databases [11] .In addition, IFT and its associated quantitative models have been used to develop and evaluate information search and summarization tools [12,13] . We believe these prior successful applications of the theory suggest its possible utility in the development of tools to summarize the information in the EHR.

Information foraging theory (IFT) is based on an analogy with optimal foraging theory (OFT) [14] ,which focuses on the optimization of costs/ benefits to an animal in its search for energy from food in a given environment. Pirolli describes the essential idea of information foraging theory as:

"*The optimal information forager is the one that best solves the problem of maximizing the rate of valuable information gained per unit cost, given the constraints of the task environment*" [14] p. 8.

The theory proposes that the individual spends their time either "within-patch" foraging, or in one of two types of "between-patch" activities: using proximal cues to make decisions about the potential value of information patches (*Scent-following*), or molding the information environment to either reduce between-patch foraging costs (*Enrichment activities).* Table 1 describes the theory's central constructs and their definitions.

Table 1. Information Foraging Theory's central constructs and definitions

Construct	**Definition / Examples from the EHR**
Information Goal	The information sought relevant to the current task / e.g. remind myself of this patient's plan of care.
Patches	Physical or virtual areas of concentrated information yield / e.g. notes, tabs, windows, etc.)
Scent	The individual's imperfect perception of the values, cost or access path of information sources obtained from proximal cues / e.g. perceptions of the value of information underlying note titles, tab titles, alerts, etc.
Resource Costs	The actual costs incurred by pursuing a given information source /e.g. time required, clicks required to locate desired information.
Opportunity Costs	The benefits that would have been accrued in pursuing a different information source, but were not gained due to the given pursuit instead
Information Diet	The range of foraging choices the individual makes amongst several potential sources.

Two assumptions of the model should be emphasized. First, the theory assumes that the value of information is not intrinsic but is dynamic and task specific. This assumption has face validity in our proposed use case: clinicians searching the EHR for data related to a patient's adherence to treatment will naturally weigh certain information sources more heavily than others. Second, the theory does not assume that the individual is classically rational with perfect information and infinite computational resources. Rather it suggests that individuals engage in "satisficing" which involves optimizing within the constraints of imperfect information and limited time and cognitive resources. Therefore, the solutions reached are not assumed to be globally optimal but allow for the specification of "information niches" that may be local maxima. Again, this approach has face validity in clinical practice. We do not expect that clinicians exhaust all possible avenues to address an information need. Instead, they make use of the data that is readily available to them to address a question, and often must make decisions in the face of uncertainty.

Methods

Human Subjects

This study was conducted in accordance with World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by the Institutional Review Boards of the George E. Whalen Salt Lake City VA Medical Center (SLCVA) and the University of Utah. Informed consent was conducted with both the provider and the patient.

Overview

This was an observation and interview study of clinicians' information search in a real clinical setting. Clinicians were asked to think-aloud as they prepared to see a scheduled patient and they reviewed the patient's chart .
This study combined direct observation and interviews with a qualitative analysis. The methods chosen for this study aimed to capture clinicians' information search as closely as possible to their uninterrupted, unobserved real world processes.

Setting

The George E. Whalen Salt Lake City VA Medical Center (SLCVA) is a 101-bed tertiary care center that provides both inpatient and outpatient mental health services. This study took place in an outpatient mental health clinic and targeted patients diagnosed with PTSD.

Description of Participants

Eight mental health clinicians from the SLCVA's outpatient mental health clinic were recruited to participate in this study. All clinicians were treating individuals with Post Traumatic Stress disorder (PTSD). Of the eight clinicians who participated in this study, seven are psychologists and one is a social worker. Six are female and two male. They ranged from less than one year of clinical experience (a post- doctoral fellow) to more than 20 years of clinical experience.
Clinicians were recruited via both in-person requests at staff meetings and follow-up emails. The first author conducted a total of 19 observations (a minimum of 2 and a maximum of 3 observations per provider) in the outpatient Mental Health clinic. To maximize variability each observation was of a unique patient visit (no repeat visits by the same patient were observed) . To ensure that adherence was a relevant concern, all appointments were follow-ups

Procedures

After completing informed consent, mental health clinicians were observed prior to their appointment with patients. As they prepared to see a patient, clinicians were instructed:

"Please review the chart as you normally would and think aloud about what information you are looking for, what information you are finding, and what you are thinking about."

The duration of the chart review duration was at the discretion of the clinician but was generally brief (5-7 minutes). After completing the chart review, clinicians participated in a semi-structured interview intended to probe for information goals and search strategies for adherence related information (the Appendix contains the interview guide). The interview lasted 10-15 minutes. When the patient arrived for their appointment, the study was explained to them and they then completed informed consent. The patient's consent simply provided the study team with access to those notes in the patient's electronic medical record that the clinician had reviewed in preparing for the visit. The think aloud and the interviews were audio recorded and then transcribed by a medical transcriptionist. All individual identifiers were removed from the texts in the process of transcription.

Data Analysis

The study team used an iterative process of qualitative analysis using ATLAS Ti@. Each researcher highlighted text they believed to represent information relevant to information search, and/or concepts of adherence. Highlighted areas were reviewed discussed by the group, and given what Patton refers to as "pre-codes" - short descriptions of the content [15] . Many of these pre-codes referred to adherence concepts, patient's response to therapy, risk assessments, and clinician's mental models of the information space. The goal was to capture concepts relating to clinician's mental models of adherence, and the information search processes related to those mental models. After additional discussion and review, the constructs were organized through consensus into higher-level categories according to Information Foraging Theory.

Results

The results presented here are organized around the constructs of Information Foraging Theory. The analysis is interpretative, using theory to explain and understand results.

Information Goals

Table 2 presents examples of text that were coded as exemplars of information goals. Information goals associated with adherence varied, and included: determining compliance with assigned homework, determining the patient's response to therapy, identifying if the patient was ready for a specific therapy, and looking for evidence of how "activated" the patient was in terms of treatment. In many cases information goals consisted of discrete pieces of information that would be straightforward to electronically query for and represent in a summarization. However, in several cases during their chart review several clinicians reported developing questions that required further follow-up with the patient. This type of information goal, one in which an original search precipitates a second information search via a different "patch" (e.g. the patient) has implications for EHR design which we will discuss later.

Table 2. Example Text for Information Goals Relevant to Adherence

Information Goals	Text
What is new with the patient?	"He was supposed to go to *event name*. So I want to ask him how that went for him."
	"Like I need to know what she's avoiding, what she's been experiencing, what else is she avoiding"
Who else is seeing the patient?	"Looking for an initial assessment by his prescriber…but it's finally notated in here who that person is"
	"He presented for PTSD assessment and I want to know who did the assessment"
How is the patient doing? Is he improving or getting worse?	"Some violent urges. Has noted that PTSD therapy is helping him, good."
	"Has he seen any improvement or any side effects?"
	"He doesn't have any suicidal thoughts or any homicidal ideation tells me that he's doing well"
Is the patient going along with treatment?	"I wanted to go check what meds he was prescribed (by a provider outside the VA) and I want to ask him about all of these today"
	"I'm going to go to my last note and confirming treatment clinic, she's going to do PE, motivated"
What is the plan of care?	"We sort of reviewed therapy goals and he wanted to focus on decreasing anger at home and focusing on behavioral activation, and exploring more leisure activities in his life."
	"Looking at the plan to see if there's other stuff in there I need to follow up on"
Is this patient appropriate for therapy X?	"I need to know this because if she's taking a benzo, that's really important to know for PE (prolonged exposure therapy)."
	"Why else was he referred for a motivational interview?"

Information Scent

Table 3 presents text snippets that were coded as exemplars of Information Scent. In most cases these references are simple, explicit cues about informativeness. However, clinicians sometimes mentioned the absence of information as a cue. For example, one clinician noted the absence of emergency department notes as a cue that her patient might be doing better. Several participants mentioned the absence of any notation that the patient was a poor historian as evidence that the patient must be a good historian and several also mentioned that the absence of notes about non-compliance to therapy was a sign that the patient was likely adherent. This particular form of Information Scent, the absence of particular information, has implications for the design of an EHR summarization tool.

Table 3. Example Text for Information Scent

Scent subtype	Text
Patient Risk Cue	"Noticed this patient has a high risk for suicide flag"
	"Recipient of Bronze Star so potentially real PTSD stuff."
	"The behavioral flags and things".
Adherence Related Cues	"He's compliant with his hearing aids"
	"She's motivated. She doesn't have no-shows."
	"The no-shows, that's something I look for especially to see how compliant they have been or avoidant they have been."
	" . . . Frequency of his appointments is usually a good sign for him. When he's coming in really regularly it means he's engaged in treatment."
	"Regularly filling his medications."
	"Vets who just fire providers all the time"
Absence of Information as a cue	"Has he had any emergency department visits? No, good."
	"There's nothing noted that he's not compliant with his current meds."
	"Poor historian we usually comment on that…"

Information Patch

An information patch is the actual location of information (rather than a pointer to that source). Table 4 presents text snippets that were coded as exemplars of Information Patches. In most cases, our participants visited a limited number of patches- mental health notes and more frequently their *own* notes, were the most common patches searched. However, in several cases clinicians mentioned information locations outside of the EHR (e.g. patients, other clinicians) as important sources. Again this finding has implication for the design of an EHR summarization tool.

Table 4. Example Text for Information Patch

Patch subtype	Text
Note Titles and Sections	"Suicide prevention team follow-up note, 21-day contact"
	"Medical notes would become more relevant if they're doing UAs (Urinalysis)"
	"Most recent prescriber note"
	"There is a part in that states that he is compliant with his medications"
Assessment Scores (Health Factors)	"One thing that I look at is where his PCL and BDI [standardized disease severity scales] scores are."
	"All right, we would definitely look at her PCL".
Other providers as a patch	"Prescriber in the hallway who asked, "Is he taking any meds?"
	"I usually have to go ask the prescriber. It's not generally in the notes"
Patients as patch	"Check in with him every time on the homework that I assign from the last session."
	" I specifically ask questions to try to get at that [patient's adherence]".

Resource Cost

Resource cost refers to the time or effort needed to find information. Table 5 presents texts snippets that were coded as exemplars of Resource Cost.

Table 5. Example Text for Resource Cost

Resource cost subtype	Text
Time/Effort required	"I have such a hard time when they're on inpatient with substance abuse, finding like a relevant, important note."
	"We spent 45 minutes in the chart looking "

Enrichment

Table 6 presents texts snippets that were coded as exemplars of enrichment (an individual improving their information environment to improve future yield). Interestingly, several clinicians mentioned a form of enrichment that is unique to the EHR: clinicians often place other clinicians as cosigners on their notes to promote a shared awareness of their patients' disease state and treatment plans. In addition, several clinicians spontaneously lamented the absence of search tools within the EHR. We note that no text was coded as representative of enrichment by improving *within-patch* yields, we will return to this in the discussion.

Table 6. Example Text for Enrichment

Enrichment subtype	Text
Reduce between patch foraging	"I just usually sort it (clinical notes) by title and then I would just look for year, any mental health notes or primary care behavioral health notes"
Identify Note Cosigner	"I cosign his treatment clinicians over there on my note to let them know how he's doing."
Absence of Search Tools	"There's no way to search [The notes in the EHR]"
	"Unless there's like a very particular key word, there's no way to search"

Discussion

In this project we explored mental health clinician's information search as they addressed questions related to the adherence of their patients. Our findings indicate that clinicians' information search in the EHR is complex and at times non-intuitive. For example: clinician's engaged in information search in one source which precipitated a second search via a different source (e.g. reading a note reminds the provider to ask the patient a particular question during the visit), clinicians reported the absence of information as an important cue (e.g. clinician noting the *absence* of emergency department notes as a cue that her patient might be doing better) and clinicians communicating with each other by placing each other as cosigners on their notes (a form of enrichment that is unique to the EHR). We believe that these findings regarding searches that are distributed over time and across patches, the absence of information as a "scent", and the social form of enrichment exemplified by cosigning, have significant implications for the design of EHR search and summarization tools.

This study is one of only a few to use Information Foraging Theory to describe the information search of healthcare workers. Dwairy, et al. studied primary care physicians when addressing clinical questions and found that colleagues and books were preferred sources of information (patches), they concluded that this was likely due to the decreased time required to answer the question compared to an electronic database search [16]. Kannampallil, et al. used a think aloud protocol and observation to examine the information search of physicians in an ICU setting. They found that physicians sought out different sources depending upon their specific information goals, and that answering clinical questions required integration of data from multiple sources. In addition these researchers estimated the relative information gain from various sources and found that electronic sources provided more unique information per unit time than paper records [17]. Our findings echo this prior work in that the "information diet" of the clinicians we studied included both human and electronic information sources. Our findings expand upon this prior work by identifying the specific patches, scents and enrichment strategies used by clinicians to address their questions regarding their patient's adherence and by noting areas where our observations will impact the design of our planned EHR summarization tool.

Implications for EHR Design

We believe that our findings offer insights into potential improvements in EHR design. First, this work illustrates how information needs are context dependent, what would seem on the surface to be the same information need: adherence, varies in content and structure depending on why the information is needed. We believe this suggests that EHR designers need to understand the reasons why clinicians might be interested in a specific class of information and then use that understanding to develop an appropriate information display. For example, a clinician wanting to understand their patient's "dose" of exposure to medical intervention might use the patient's attendance at medical appointments as one measure but would likely want to correlate this with other measures (e.g. frequency of appointments, number of unique providers, number of medications, etc.). Conversely, a clinician wanting to understand how "activated" the patient is might correlate the same appointment attendance information with a different set of measures (e.g. patient reported activation, reports from other providers, measures of health related behaviors). We believe that our findings suggest that EHRs should provide integrative displays that address the user's information needs in context. Second, our finding that clinicians use multiple information patches to address a single overarching information need suggests the need for the inclusion of a broader range of data into the EHR. For example including patients' functional and social data in the EHR [18] would reduce clinicians need to search outside of the EHR for this data, allowing for easier mental integration of this data with clinical data and therefore greater efficiency. Third, the concept of information "scent" seems critical to improving EHR design. Clinicians clearly sought out specific patches depending upon the limited scents available (e.g. note titles). The EHR could provide stronger "scents" regarding the location of specific information types. These scents might include cues as to the content of specific patches as well as critical metadata such as certainty (e.g. provisional vs. confirmed diagnosis) and currency (e.g. historical problems vs. current problems). We hypothesize that an EHR that provided these cues would improve the efficiency and accuracy of clinician's searches. Finally, our results suggest that clinicians clearly want EHRs that allow them to enrich their information space. This would include: the ability to aggregate data elements that are relevant to specific clinical questions from a variety of patches, the ability to search within patches to more efficiently locate specific data, and tools to communicate and collaborate with other clinicians.

The results of this study will inform our future work in developing an EHR summarization tool. The non-obvious nature of providers' mental models of the information space suggests that creating a map between clinical questions and information needs will likely require involving providers themselves. One potential method to accomplish this would be for providers to use tagging tools to identify data elements and patches that are relevant to specific clinical questions. This mapping could be available for future use by an algorithm as well as for sharing with other providers (e.g. collaborative search). To address providers' need for the capacity to enrich within-patch yields, we might provide the ability to search for concepts semantically related to a given keyword within notes. Finally, the use of cosigning to promote shared awareness and the adding of amendments to clinical notes as a tool for collaboration, points to the need for communication and collaboration tools in the EHR.

Strengths

This study has several strengths. First, we used a well-established model of information search (Information foraging theory) as our conceptual framework. Second, we used two types of qualitative data (think aloud and interviews) to capture different perspectives on clinicians' information search. Third, we used iterative thematic coding to minimize bias in our findings.

Limitations

This study has limitations. Since the sample size was small and the data collection was restricted to mental health clinicians treating individuals with PTSD, the results may not generalize to other domains, therefore further work is needed to validate these preliminary results. It is also worth noting that we did not address or control for how long the clinicians had been seeing the patient; the duration of this relationship may have affected clinicians information search, future studies should account for this important factor. In addition our measurement of information scent relied on provider's report of what they considered cues to important information. In future work we could improve upon this by measuring the clinicians' gaze, this would allow us to note the information cues that providers both consciously attend to (gaze at and comment upon) and implicitly attend to (gaze at without awareness) and then either pursue or do not pursue, thus providing a much richer representation of information scent [19] . Finally, in this study no text from our transcripts was coded as representative of "opportunity costs." In future work, this might be addressed by prompting participants to reflect on the expected value of the search within a specific patch relative to querying an alternative source (e.g. look in a different part of the EHR, telephone the patient to answer this question).

Conclusions

In this study we combined think-aloud and semi-structured interviews to understand mental health clinicians search for adherence related information. We found that clinician's information search to understand their patients' adherence is complex, and at times non-intuitive. We believe this foundational work is a useful first step toward the development of EHR summarization tools that will improve the effectiveness and efficiency of clinicians' information search.

Appendix: Semi-Structured Interview Guide

1. What tells you that the patient is doing better or worse?

2. What in the note informs you if the patient is adherent to recommended treatments or not (whatever the treatment is – e.g. medications, therapy, CBT, group)

3. If the patient is not adherent, what information in the notes is most helpful to determine WHY the patient is non-adherent?

4. What information would inform you about the likely consequences (for the patient and others) that are likely for being non- adherent?

5. Where do you look in the notes to find out if prior interventions have been done to address non-adherence and how well they worked?

6. Looking in the chart, would there be any reason to suspect that the patient is not a good historian?

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