Digital Healthcare Empowering Europeans
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A User-Editable Web-Based Platform to Streamline Clinical Information Flow

Mark FINKELSTEIN[a,1], Ammar SIDDIQUI[a], Theodore PAK[a], Kevin HU[a], Chloe CICCARIELLO[a], Vinicius KNABBEN[a], David CHIANG[a], David C. THOMAS[a] and Yasmin S. MEAH[a]
[a] Icahn School of Medicine at Mount Sinai, New York, NY, USA

Abstract. Frequent turnover of staff in medical clinics creates challenges in the maintenance of clinical protocols, workflows, and information management. Care coordination between providers in such a setting can be complex; disruptions in communication may lead to poorer health outcomes and patient satisfaction. Furthermore, protocols change frequently in response to new guidelines, which demands rapid updates to maintain compliance. To address these challenges, we developed an intuitive, end-user editable web-based knowledge management system optimized for use on mobile devices. The resulting system served as a point of care information storage and retrieval tool that providers can reference quickly for operational tasks. Since launch, the platform has allowed our clinic to consolidate knowledge banks, standardize staff training, and streamline information flow during clinic, and is now used extensively by clinic staff. During a one-year period, 175 new pages have been created and 1686 edits have been submitted by users. We posit that a mobile platform for clinical information flow management has significant potential to improve information maintenance and facilitate transfer of up-to-date clinical protocols to new personnel.

Keywords. Educational Technology, Mobile Applications, Knowledge Management, Student-run free clinic

Introduction

High turnover is a fundamental characteristic of medical training programs, such as medicine residency rotations. As new interns continually enter the program and the most experienced residents eventually leave the program, institutional knowledge is effectively lost as soon as it is mastered. By capturing, codifying, and disseminating this type of knowledge within electronic platforms, the longevity of institutional memory can be increased.[1] The latest developments in knowledge management systems (KMS) attempting to harness mobile or other technologies for this purpose

[1] Corresponding Author. email: mark.finkelstein@mssm.edu

have thus far encountered mixed results.[2,3] In the broader view, KMSs have been found to improve health care process measures, though evidence for the effectiveness of KMSs on clinical outcomes and cost remains sparse.[4]

The East Harlem Health Outreach Partnership (EHHOP) is a student-run, physician-supervised free clinic (SRC) at the Icahn School of Medicine at Mount Sinai, which provides comprehensive clinical care to uninsured adults living in the East Harlem neighborhood of New York City. Like many other teaching clinics and hospital inpatient services, EHHOP faces coordination of care challenges in the form of frequent staff turnover, varied training processes for different care teams, and ever changing hospital protocols and community resources. Together, these factors fragment information exchange and contribute to a continual loss of institutional knowledge. In response, we created a mobile-optimized web application, the EHHapp, as a KMS that crowd-sources the task of knowledge management. In this paper, we outline the methods we used to develop this platform, how we integrated this platform into clinic flow, and the support infrastructure we developed to ensure the sustainability of this platform as a tool for information exchange across team transitions.

1. Methods

The ideas behind the EHHapp followed accepted core characteristics of a KMS: i) to consolidate fragmented knowledge banks into a central, transparent, and conveniently accessed platform; ii) to ensure an intuitive platform for end-users, with minimal training for information retrieval and re-use; and iii) to minimize barriers to editing the platform to ensure its information remains up-to-date.[5] Sinatra, a Ruby-based web application framework, was used alongside the Git distributed revision control system on a hosted, virtual private server running Debian GNU/Linux (figure 1). Git was chosen as the primary content database because of its stability and rich feature set for version control of documents, including the ability to merge edits made on different versions of a document at different times. The client-side user interface relied on jQuery Mobile to optimize widgets for mobile platforms, providing similar appearance and functionality to native iPhone or Android apps. To ensure editing remained organized, editing permissions were given to users only after their identities were confirmed using hospital email accounts, and an editing hierarchy was developed with moderators for each page approving edits from other users (figure 2). All pages are submitted and edited in Markdown, a simple text formatting language used by many popular websites.

In order to consolidate past knowledge, the existing knowledge banks of each of the clinic teams were examined. Some knowledge banks were hosted on separate websites and paper binders, while others were unwritten and passed down by word of mouth from team to team. Information from these banks was collected and consolidated into a single database, and used to develop protocols for coordination of care, with the goal of each protocol to minimize patient discomfort and costs, reduce redundancies, and speed up access to care. Administrators at specialty clinics at Mount Sinai Hospital (MSH) were contacted and logistical information for specialty services such as wait times, costs, pre-appointment lab requirements were obtained as well. Additionally, the clinic's formulary (including price-per-pill), training documents for each team, and illustrated guides for meaningful use of the Electronic Medical Record (EMR) system were developed and added to the platform. In addition to team-specific

training sessions on how to use the platform, all student volunteers receive 2 hour-long training sessions during their four years of medical school—one at the beginning of their preclinical year and one at the beginning of the clinical years.

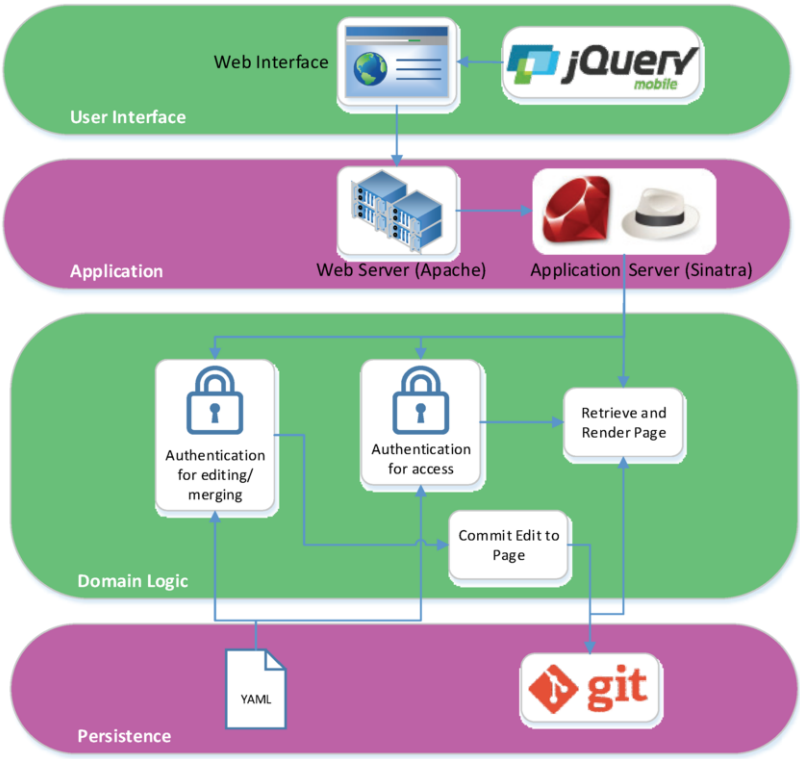

Figure 1. Functional diagram showing the structure of the application. Authentication is described in figure 2.

2. Results

The EHHapp was deployed in 2012 and was supplemented with editing capabilities in 2013. By accessing the EHHapp at http://ehhapp.org, users have access to a simple user interface with a list of services, each linking to their own page, and a search box containing the prompt "My patient needs…" to help users formulate a useful query. Each service's button links to a checklist of protocols each team is responsible for in order to secure the service for their patient, as well as the expected wait time for the service. The editor interface includes directions, several user-interface templates that editors can employ at their discretion, and the ability to control which users have page-access (figure 2).

Since the editing interface went live in 2013, 175 pages have been created and 1686 edits have been submitted (figure 3). In addition to ensuring the information on the platform stays up to date, students have taken advantage of the editing function to generate new content. This includes a price-per-pill formulary of medications available to the uninsured patients at EHHOP, illustrated how-to guides for meaningful use of the clinic's EMR, internally researched screening guidelines for East Harlem patients, a

list of community resources that staff at the clinic visited and vetted, customized apps incorporated for specific functions, such as a bilingual depression screening calculator (Patient Health Questionnaire-9).

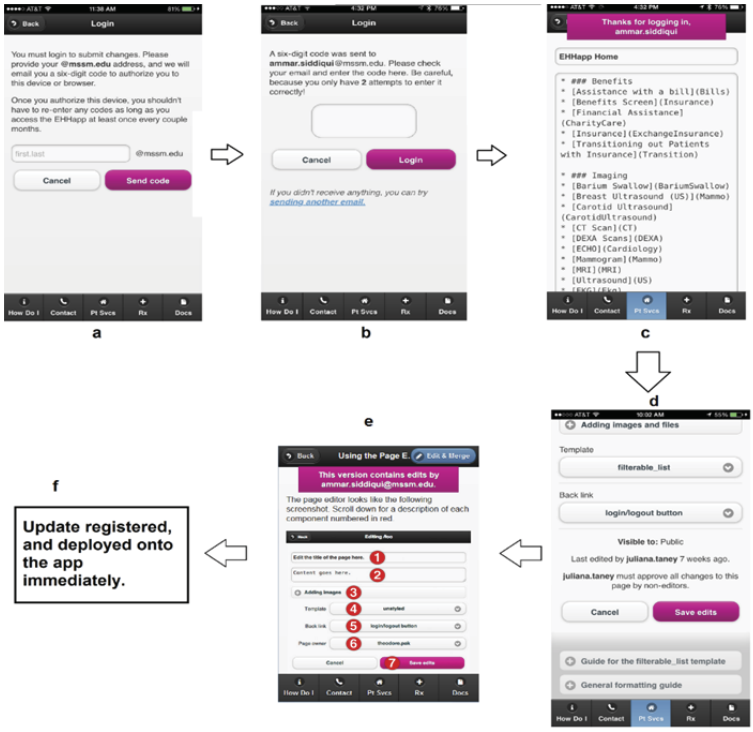

Figure 2. A flowchart showing how the platform is updated. a. Users wishing to make changes enter their hospital email and receive a code which they enter in. b. Once the code is entered, the authorization process does not need to be repeated on the phone being used again. c. Changes are made by editing the text in the page's text-writer using the Markdown language. d. Users can select preset templates for the page from the dropdown menu, select which users will be able to view and edit content, and consult a guide on how to edit the platform. Once the user is ready, he clicks the save edits button. e. The page's editor receives an alert by email, and they can choose whether to approve or deny the changes.

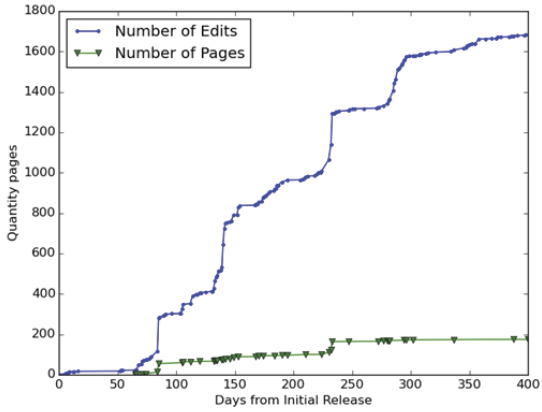

Figure 3: The number of pages and cumulative number of edits over time starting from deployment of the editing feature. Each point represents a page submission or edit event.

3. Discussion

Several studies have already introduced the use of KMS into the clinic as a way of helping clinicians provide better and more informed care to their patients.[2,4] Our interest towards KMS was raised by the need to maintain institutional knowledge in the face of high turnover, and the hope that faster information retrieval at the point of care would help our clinicians make better decisions among the full range of resources and referrals available to them. A web-based application accessible via browsers on desktops or smartphones seemed to be the most appropriate technology for implementing a KMS, as both are readily available to EHHOP clinic staff, providing practically no barrier to quick adoption.

Widespread adoption of the EHHapp throughout our clinic, along with requests for further expansion, validate its significant utility to end-users. EHHOP clinic staff currently participate independently in the process of capturing, organizing, retrieving, and revising content without any direct oversight by the maintainers of the site's infrastructure. The federated moderation structure allows individual teams within the clinic to self-regulate standards for their own content, while the sharing of knowledge across teams has increased, since all content is created and maintained within one unified platform. Because of this, EHHOP's horizontal transparency has been enhanced, since pages on the EHHapp maintained by each team readily illustrate what those teams are responsible for and how each team might be able to contribute to a particular patient's care.

In continuing this project, we intend to enhance the features available to EHHapp users and foster its implementation in several practice settings, such as internal medicine clinics, home visit services, private practices and inpatient services. The EHHapp platform can be easily shared with other practices as a template for storing their own protocols and workflows in a similar mobile website.

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