Research Note

DESIGNING A SOCIAL MEDIA PLATFORM IN SUPPORT OF KNOWLEDGE SHARING IN HEALTH CARE USING SYNCHRONOUS VIDEO COMMUNICATION

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Abstract

Online social networks are evolving as platforms for health communication among the public, patients, and health professionals. Many existing health social network based portals do not provide synchronous-video-based communication features and are restricted to only text and picture based content sharing. Arguably, healthcare focused online social networks need video based communication for active knowledge sharing between providers and patients, peer-patients, providers and specialists, etc. for sharing disease related information. This study provides a technological framework and design architecture to develop a customizable online healthcare social media network that can incorporate synchronous video communication capability as one important option for knowledge exchange. The design principles and layers that support different types of functionality are described.

Keywords: social network, knowledge sharing, synchronous video communication, healthcare, multi-tier application architecture

INTRODUCTION

Use of online social health networks is increasing with the understanding that online communication and support is highly effective to manage own health (Giustini, 2006; Heidelberger, 2011; Thackeray, Neiger, Hanson, and McKenzie, 2008). In addition, online social media platforms are providing conduits for providers to increase clinical competence of healthcare practitioners through constant monitoring and support mechanisms (Green and Hope, 2010; McNab, 2009).

Social media are "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and allow the creation and exchange of user generated content" (Kaplan and Haenlein, 2010). Social psychology related discussions have established that social media consist of two components: the media-used and the social interaction. The media component emphasizes the degree to which different types of social media come to support synchronous face-to-face communication, and their effectiveness in reducing ambiguity and uncertainty (Short, Williams, and Christie, 1976). The social interaction is based on the notion that individuals' interactions have a purpose: control others' impressions of them or

providing a set of socially recognizable actions to impress others (Goffrnan, 1959). Nevertheless, social media allows users to generate, share, receive, and comment on social content among multiusers through multi-sensory communication (Kamel Boulos and Wheeler, 2007; Kaplan and Haenlein, 2010).

The emerging use of social media in healthcare is centered around interactions between individuals and health organizations, and the nature and speed at which these interactions support communication of health related issues (Frost and Massagli, 2008; Hawn, 2009; Landro, 2006). In the United States, 61% of adults search online and 39% use social media such as Facebook for health information (Fox and Jones, 2009). Globally, the adoption rate is similar, such as 45% of Norwegian and Swedish hospitals are using LinkedIn, and 22% of Norwegian hospitals use Facebook for health communication, and Facebook is emerging as the fourth popular source of health information in UK (Heidelberger, 2011). Moreover, with the focus on decreasing the growing healthcare costs, social media is posited to provide a cost-effective means to support patient-doctor interactions (Hillestad, Bigelow, Bower, Girosi, Meili et al., 2005).

Irrespective of the increased use of social media sites in healthcare, design issues have posed significant challenge for their effective use in diagnosis, treatment, and care related interventions. Specifically, the lack of synchronicity among these sites is a major issue for both patients and providers. For example, a patient cannot get an expert opinion when needed and has to rely on unreliable opinions from friends and family on, say breathing issues due to asthma, by logging into a social network sites given that many use archived information. Several healthcare social networking portals use communication methods such as emails, published articles or discussion forums (see Table 1 for a selected list of these portals and their features). They typically do not support synchronous communication for online consultation, which can improve constructive dialog between health professionals and patients. To our knowledge, no social network portal has the capability to make a doctor available to a patient through a video communication instantly. Furthermore, as healthcare depends on the evidence based visual diagnostics, synchronous video communication can be used to establish visual clues in support of care delivery.

The study discussed uses the design science approach to design an information technology artifact to address this key care delivery challenge (Hevner, March, Park, and Ram, 2004). We articulate that health care delivery requires an integrated knowledge sharing framework that necessitates certain technological architecture to design a synchronous video based communication. Based on the developmental experience of one such architecture, we suggest generalized design and architecture elements that can be incorporated in the future. Implications and contributions of this research note are discussed.

TABLE 1: Sample Healthcare Web Portals and Social Media Sites

Website Name & URL	Focus	Communication Methods	Content Categories
Steady Health www.steadyhealth.com	How to live healthily under different categories. Covers disease treatments and diets.	Information Center; Articles; Discussions; Videos; Slideshows; Medical Answers; Applications	Categorized by: Well Beings (purposes); Health Conditions (disease types); Family Heath (Sex and Age); Therapies & Treatments; Emotional & Mental Health
Wellness www.wellness.com	How to live healthy under different categories. Covers disease treatments and diets. Also, information about fitness and beauty.	Blogs; Forum; Articles	Popular Topics; Facilities; Fitness & Beauty; Dental Care; Stores; Insurances; Doctors; Mental Health; Counseling; Provider Program; Community
Everyday Health www.everydayhealth.com	Diseases, drug information, living healthily (food & diet).	Articles; Videos; Twitters; Facebook; Blogs; Applications	Conditions (diseases); Drugs; Health Living; Food & Recipes; Advices & Support
Find a doc www.findadoc.com	Devised a unique proprietary rating system that helps patients choose from among the 720,000 practicing physicians in the U.S.	NA	Contact Information Search by Categories
My doc hub www.mydochub.com	Offers doctors' information, hospital information and diseases information.	Articles; Discussions; Blogs; Applications	Doctors; Reviews; Dentists; Blog; Answers; Chiropractors; Hospitals; Vets; Health; News; Health A-Z; Articles
Spark People www.sparkpeople.com	Focused on living healthily depending on food and exercises.	Information Center; Articles; Discussions; Videos; Boards; Applications	Eat Better; Feel Better; Look Better
Physician Data Query www.cancer.gov/cancertopics/pdq	PDQ (Physician Data Query) is NCI's comprehensive cancer database.	Search Engine	NA
Health grades www.healthgrades.com	Doctors' information, hospital information and dentists' information.	NA	Find Doctors; Find Dentists; Find Hospitals
Vitals www.vitals.com	Find and review doctors, make an appointment and prepare for the doctor visit.	NA	Patient Education; Write a Review
RatMD.com www.ratemds.com	Find and review doctors and hospital information.	FAQ; Forums; Tweeters	Find a Doctor; Find a Doctor; Browse Doctors; Hospitals; Top Local Doctors; FAQ; Forums
Drscore.com www.drscore.com	Find doctors information.	Email	Find a doctor; Score your doctor; For Patients
Doctortree.org www.doctortree.org	Find doctors information.	NA	Search Engine by Categories
Suggest a doctor www.suggestadoctor.com	It helps to find doctors information.	Customers' Evaluations	Search Engine by Categories
Healthcare.com www.healthcare.com	Information about health insurances.	NA	NA
Vimo www.vimo.com	Information about health insurances.	NA	NA

BACKGROUND AND KNOWLEDGE SHARING FRAMEWORK FOR SVC

Existing literature points to several limitations of social media for health care related communications. Moorhead, Hazlett, Harrison, Carroll, Irwin et al. (2013) point out that quality concerns, lack of reliability of information, and blurred lines between content producer and user are three major limitations. Beyond these limitations, the most important one is the "information overload" and "lack of validity of the information" as this poses a bigger challenge to the use of the social media for meaningful purposes (Adams, 2010). Lack of guidelines may lead to public not correctly applying information found online to their personal health situation, possibly leading to adverse health impact or consequences (Freeman and Chapman, 2007). There is limited evidence on the efficacy of online communities in their ability to support effective delivery of health related information to patients and positively impact people's health (Colineau and Paris, 2010). All these contribute to providers not actively participating in online social health networking portals (Kim, 2009).

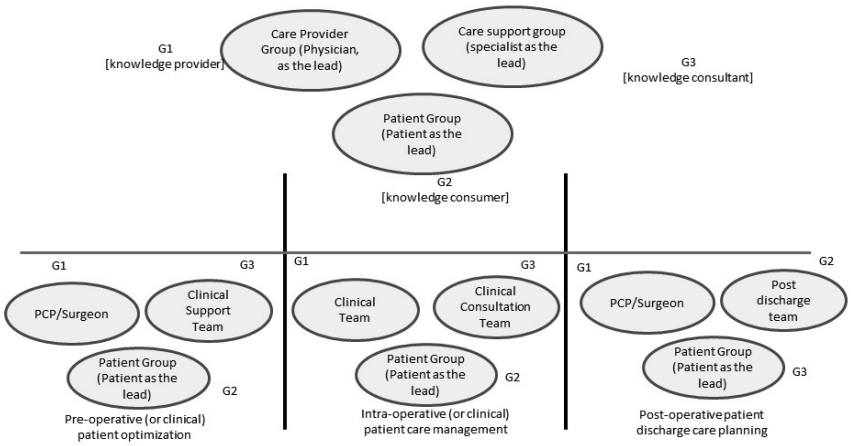
Existing studies have suggested three plausible alternatives for greater provider engagement (Lagu, Hannon, Rothberg, and Lindenauer, 2010). First, similar to Internet sites, there is a need for greater interactivity in the social media for patients to upload information in free form and not be constrained by medical jargon or established diagnostic codes and terminology. The information posted will be meaningful to the patients experiencing the disease symptoms or post-treatment effects (Adams, 2010) and may help providers glean useful insights into the underlying patients' needs and concerns. In support of the suggestion to improve the media synchronicity, this study tries to fulfil the gap by proposing a synchronous video communication (SVC) framework and design in healthcare context.

Knowledge Sharing Framework in Health Care Delivery

Health care interactions need effective exchange of knowledge among various stakeholders. We describe three types of knowledge exchange among different stakeholder types: knowledge providers (G1), knowledge consumers (G2) and knowledge consultants or those with specific knowledge in support of complex decision making (G3). A patient is arguably the knowledge consumer and a physician is the knowledge provider. It is assumed that basic information/data is exchanged between the patient (e.g. medical history) and the physician (medical diagnosis). The special knowledge or expertise that a physician provides is pursued by the patient before or during the care delivery process. When the treatment decisions become complex, either a physician or a patient may consult the views of another expert (here we refer them as knowledge consultants). This basic knowledge exchange framework is shown in Figure 1. Often the entities (patient, physician and consultant) extend to multiple members (e.g. patient may have family and support members as members of the knowledge consuming group) and physician and consultant may have their own groups to support their participation in the knowledge exchange. Such membership in

groups is becoming more critical today given the evolving role of medical homes and specialist clinics where a patient may consult any available physician or specialist in the respective groups to answer a patient inquiry.

FIGURE 1: Patient Progression in a Surgical Unit and Knowledge Interactions



The structure shown on top of Figure 1 is similar to a typical consultation post-treatment for a specific pain or medication related question (where often social media interactions are used), or as a part of a diagnosis of an illness based on a set of symptoms observed (where a physical visit to a clinic is often the frequently used approach, even though telemedicine technologies are allowing for remote diagnosis of a patient by a physician for certain types of illnesses). However, as shown in the bottom part of Figure 1, the role a member within a group plays may vary depending on the phase a patient is in during the care delivery cycle. In other words, the roles of knowledge providers, consumers and consultants may change when knowledge exchange is viewed along a longer care path (as in surgical context).

The surgical operations typically consist of three stages: (1) pre-operative care, where the patient is being prepared by primary care physician, surgeons and family for a surgical procedure, (2) the intra-operative care, where a clinical team engages in the surgical process for a successful outcome, and (3) post-operative care, where discharge care is planned for patient recovery post-surgery. In the pre-operative stage, the primary care provider and surgeon are the knowledge providers (G1) and the patient and the family (G2) are the knowledge consumers, as they discuss the surgical procedure and eventual outcome/consequences. The surgical team and/or patient may consult others (G3) regarding the surgical decision if needed. Similarly, in the post-operative care, the post-discharge care providers are the knowledge consumers (G2) on how to treat the patient post-surgery for effective recovery and the clinical team is the knowledge provider (G1), while patient/family may act as

knowledge consultants (G3) as they provide specific information related to constraints/options available at the patient's disposal for treatment success.

Features of Synchronous Communication for Knowledge Exchange

Knowledge conversion process is enabled by various communicative and non-communicative media (Massey and Montoya-Weiss, 2006). Knowledge management systems (technical, organizational, and expert based) support the knowledge exchange process (Alavi and Leidner, 2001). While the knowledge exchange is focused on the patient, the effectiveness of the structure is a broader area of discussion, especially in existing healthcare practice and academics (Wickramasinghe, Gupta, and Sharma, 2005). As multi-actor multi-role knowledge exchange architecture supports various instantiations of knowledge exchange and coordination, the role of synchronous video communication (available when needed) in different security formats (public or private) is essential for patient support.

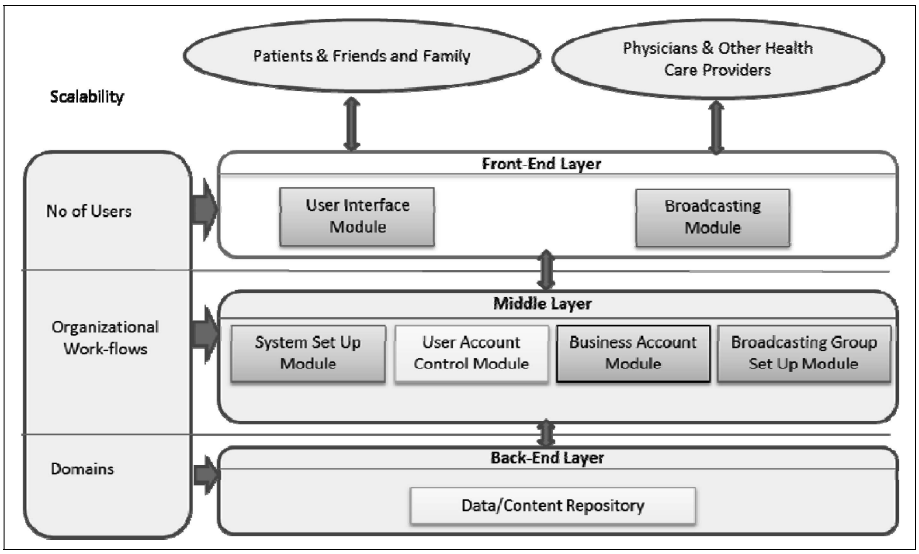
In existing information systems research, media synchronicity is defined as " the extent to which a communication environment encourages individuals to work together on the same activity, with the same information and at the same time; all to support shared focus." (Dennis, Valacich, Speier, and Morris, 1998). Further, media synchronicity theory states that the media used has to support specific abilities. These abilities include: *transmission velocity, parallelism, symbol sets, rehearsability and reaccessability* (Dennis et al., 1998). Transmission velocity implies scaling up to groups than one member. Parallelism refers to member talking to different groups simultaneously. Symbol sets indicate a commonly agreed upon terminology that is used is local to the group and can be shared with another group easily. Rehearsability addresses the concern related to testing in public or private modes, depending on the comfort level of the users on both sides (e.g., patient and physician), and reaccessability refers to the feature of saving and re-using the interactions at a later point of time.

In addition, the outcome centered approach with a shared focus is highly relevant in the health care delivery process. As media synchronicity theory (Dennis, Fuller, and Valacich, 2008) proposes, to reach a shared outcome in a group setting two primary processes are important. These are: (1) Conveyance: the exchange of information. Here, not all participants need to agree on the meaning of the information or even focus on the same information at the same time. Low media synchronicity is generally preferred for the conveyance process. (2) Convergence: the development of a shared meaning to information. Here, all participants must work together to establish the same meaning for shared information. High media synchronicity is generally preferred for the convergence process. The SVC design supports the features discussed above to ensure that the knowledge exchanged can lead to outcomes with shared focus, as well as enable varied types of knowledge exchange at different points in the care delivery life cycle.

DESIGN FEATURES AND ARCHITECTURE FOR SYNCHRONOUS VIDEO COMMUNICATION

The synchronous video communication (SVC), designed to support health related discussions in a social media context, uses features along three layers: input (front-end), application (middle) and database (back-end layers). The front-end layer is designed to support two types of stakeholders: (1) users, consisting of patients, friend and family and (2) providers, consisting of physician, nursing staff, provider organization employees. The system design architecture has the objective to support the design features discussed in the previous section. Figure 2 provides the system design architecture for synchronous video communication in social media, used in the context of physician-patient interaction. The architecture consists of several components in the three layers: (1) front-end layer, (2) middle layer and (3) back-end layer. The goal is to provide easy and secure access to the video content, and support the associated social media interaction between patients and providers. The middle layer is designed to support the workflow management necessary for the distribution of the content to meet care provider's policy needs and interaction with the content to meet the healthcare needs of the patient. The front-end layer is for user inputs and interactions. The back-end layer is designed to support the creation, customization and search functionalities of the SVC.

FIGURE 2: System Design Architecture for SVC in Social Media



User Interface Requirements - Front End Layer

The user interface requirements of the front-end layer focus on *accessability* and *reaccessability* related features: *ease of access, secure access, and saving-mode-access.* The ease of access in SVC calls for both *effectiveness of information and mobility for users.* To enable these features, the front-end layer consists of two major architectural modules: (a) user interface module and (b) broadcasting module. The *user interface module* is responsible for providing easy-to-use interface and user authentication for secured access or search options. The user interface module allows the users to log in and browse, search for friends, or invite a group to join through web browsers. The home screen consists of three panels: top menu panel, left menu panel, and outcome display panel in the middle.

The menu items in the *user interface module* are grouped into the top menu panel or the left menu panel based on the functionality in order to minimize scrolling or disrupting the view of the outcome panel. To help users' search, keyword search using text box or drop down search menu from a set of pre-defined categories is designed. *The broadcasting module* is responsible for creating and customizing the broadcasting contents. This module is only available for the account registered as a broadcast owner. Once the broadcasting feature is set up by the middle layer, the owner - health professional - can customize broadcasting settings. The system is designed to leave zero-foot print on the client site by having the console program download the needed information from the back-end server wherever it is needed. Once it is downloaded, the console program indicates whether it is on air or not, and displays the same screen users see on their website.

Application Requirements – Middle Layer

The application layer is designed to address three needs: (1) alignment/support with organizational workflows, (2) accommodation of domain diversity, and (3) scale up to meet an increase in the number of users. These features address the convergence and conveyance modes needed for a synchronous knowledge interaction; along with meeting the feature demands for *transmission velocity, parallelism, and symbol sets.* The middle layer has four major architectural modules: (a) the system set up module, (b) the user account control module, (c) the business account module, and (d) the broadcasting group set up module. *The system set up module* is responsible for defining parameters that will be passed to the browser to control the behavior of the application. *The user account control module* provides a mechanism for users to set up accounts. *Business account module* helps to implement organizational workflows and business processes. For example, business activities are recorded to track the status of recruiting or contacting potential broadcasters or any issues related to broadcasting, etc. *The broadcasting group set up module* interacts with the video streaming service and builds a container that includes all necessary functionalities including live video broadcasting, scheduling, off-line recoded video, and other training material management. Once the broadcasting group is set up through this

module, the container is created and stored into data/content repository with a unique identifier.

Database Requirement – Back End Layer

The back end layer includes a database engine that is designed to support *content creation or development, content customization and content search.* Similar to the middle layer, the back end also focusses on *transmission velocity, parallelism, and symbol sets* features; by addressing the speed of content, the customization needed for parallelism and the content related to symbol sets.

The health care content in healthcare is changing rapidly and physicians and other health care providers may update the content used by patients at a more frequent rate. Thus, ease of update of content becomes critical to maintain the effectiveness of the site. Furthermore, given that the context of patient inquiry will change with time, there should be provisions for customization by patients, so that patients can select the right healthcare domain to share it with others and consult/pose questions to physicians. Finally, as the content stored grows over time, ability to quickly and effectively search and select the content that patients need becomes an important criteria for the design of the system.

This layer is a repository that stores all the data and the containers made by modules in the front-end layer and the middle layer. This repository is designed and structured so that the stored scripts, templates, or objects can be shared and reused especially by the broadcasting group set up module of the middle layer and the broadcasting module of the front-end layer. When a new broadcasting group is created, a separate container for the group is created in this repository. In addition, when parameters are changed in the front-end layer, these changes are updated into the flash script stored in the corresponding container. Most of the data in this repository are represented by the relational data model and built on MySQL program. The chat content and user list of each group are also stored into the repository, and constantly updated by the broadcasting module of the front-end layer.

The proposed platform has the capability for a live debate, where two health professionals from two different remote locations can debate or share knowledge with others at the same time. Within the broadcasting group set up module, there is a built-in service to merge two groups into a single new group. Once a new merged group is created, the portal is able to broadcast two live feeds. Furthermore, to help users to advertise the site to broader public quickly, the platform has a built-in capability for users to send invitations to their friends or contacts in email accounts or Facebook. This word-of-mouth function will accelerate people to spread and share the site with friends easily and quickly. Along with the functionalities described above, the proposed system has the following additional features: profiling, messaging/email communication, finding, and connecting with friends, searching for

places of interest, friend's whereabouts, and joining together with friends, filtering profanity, setting up campaigning and promotion of events.

Thus, to summarize, user interface requirements of a synchronous video communication feature design for a social media platform need to accommodate some salient features in its front-, middle- and back- end layers. The next section will discuss the implications and contributions of the SVC platform as well as some limitations.

DISCUSSION

There has been a strong need to facilitate communication among various stakeholders in healthcare ecosystem to reduce costs, and reduce communication gap between healthcare providers and patients. Till now, hospitals have created multidisciplinary clinics in which cancer care experts, for example, set up a weekly tumor related discussions and treatment plans for cancer patients at their hospitals. But the effectiveness of such face-to-face meeting is limited due to the locality and time related constraints. By using a system such as the one presented in this paper, hospitals can broadcast their weekly meeting to more people or public and help improve their awareness of cancer treatments and educate them on the importance of preventive care. In other words, the platform could be used for patients or interested public to be connected to hospitals on the health issues in many different ways.

From the provider's perspective, as press reports (Park, 2013) indicate, there is a trend in group medical checkup across providers. Since 2005, the percentage of U.S. family-medicine practices offering group visits has doubled, from 6% to 13%. The proposed platform could be easily implemented to accommodate this kind of group consultations even remotely. Second, in the context of social-media site management, as the user size grows, accommodating the growth to support features is one of the big challenges. The proposed platform builds the site from the beginning to support the user growth (built-in access control and workflow processes). With the movement in US healthcare towards a data-driven approach rather than hard-coded values for key parameters, the system provides a build audit-trail of key parameters in the system.

The proposed system provides several key benefits that go beyond one provider or one disease setting. First, the system can provide information sharing platform with real-time interactivity between the parties. Second, the system design is centered around providing flexibility of building communities or targeted markets amongst parties based on their interests, while providing control to the information disseminated. Third, the portal can make expert information available in public or in private, depending on the modalities of operation. Because the information will be provided by expert's live video rather than simple blogging or email communication, the patients or information recipients' satisfaction and trust will increase, as the

systems allows for two-way real-time communication between the parties through live chat.

Future work will continue to look at leveraging the benefits of synchronous vide communication system on a broad scale. For example, using the system, providers can take an advantage of social graphs amongst users and identify their potential healthcare needs. In addition, the system can provide a way to schedule live video broadcasting vs. recorded video broadcasting for the content-providers. It can also provide weekly or daily live broadcasts from experts on various medical fields. Finally, providers may use and implement cloud computing with an effort to minimize broadcasting costs.

Limitation may come with the use of PC based environment in existing design. As the next generation of computing is moving towards mobile-based platforms, there is a need to continually address the need for interoperability between PC-based and mobile platforms, such as the live or recoded videos, live chat on mobile devices, etc. While some of these are embedded in the architecture proposed here, more work will be needed to test and validate the usability and efficacy of the system in mobile platforms. While highly mobile, web-savvy consumers can interact and gain the knowledge needed in support of care delivery using mobile supported platforms, such use may have to be balanced with the need for privacy and security among patients and healthcare providers.

The lack of effective communication between patients and health professionals has been a problem and this study proposes a social network platform that features interactive and synchronous communication through live chat and video capabilities, not currently available in healthcare social media sites. Although it is expected that healthcare professionals will continue to work to reduce communication gaps with this virtual live communication, currently there is lack of empirical data to support the claim. A pilot study is currently being planned with a physician in Rheumatology and back pain management settings to see how well patients will use and interact with such a system.

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