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## An Empirical Validation of the Patient-centered e-Health Framework in Patient-focused Websites

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# Communications of the Association for Information Systems

CAIS 

## An Empirical Validation of the Patient-centered e-Health Framework in Patient-focused Websites

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### Abstract:

Although the Internet is in its second decade of wide-spread adoption, many patient-centered health websites are still in a phase of early adoption, scrambling to define and defend market segments in a shifting healthcare information landscape. Consequently, healthcare and health information providers are jockeying for position in a dynamic industry trying to serve different patients' needs. To understand the situation, this article takes the approach of Patient-centered e-Health (PCEH) and makes three contributions. One, we empirically test the PCEH framework on patient-focused websites. Two, given the PCEH framework, we identify five categories of websites that serve different segments of the patient-centered health information market. Three, we analyze the five categories in terms of different features and derive a classification model. This article helps us better understand PCEH websites and guide the future development of online healthcare and health information services.

**Keywords:** patient-centered e-health, consultation, patient records, monitoring, community, information websites, classification framework

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## I. INTRODUCTION

Patient-centered e-Health (PCEH) is a new and important framework, a theoretical advancement used to conceptualize the academic literature and distinguish three aspects of e-health: Patient-focus, Patient-activity, and Patient-empowerment [Wilson, 2009; Wilson, Wang, and Sheetz, 2014]. Websites have become an easy-to-use, useful, and trustworthy source of information for many types of users [Gefen, Karahanna, and Straub, 2003; Pavlou, 2003]. Their design, interactivity, and usability have improved, becoming interactive and enjoyable, sometimes enabling immersive user experience [Kamis, Koufaris, and Stern, 2008; Koufaris, 2002]. The variety of websites devoted to health information has been proliferating as well [Boulos, Maramba, and Wheeler, 2006; Eysenbach, Powell, Kuss, and Sa, 2002; Krist and Woolf, 2011]. A Google search for “health information” and “patients” returned more than 42 million results on December 3, 2012. PCEH helps us organize and make sense of the growing number of websites devoted to patient health. (Note that by using the term “patient,” we also include a patient advocate, such as a family member. We use “patient” for the sake of brevity.) The websites vary considerably in what they offer patients, how they encourage involvement, and how technology is deployed.

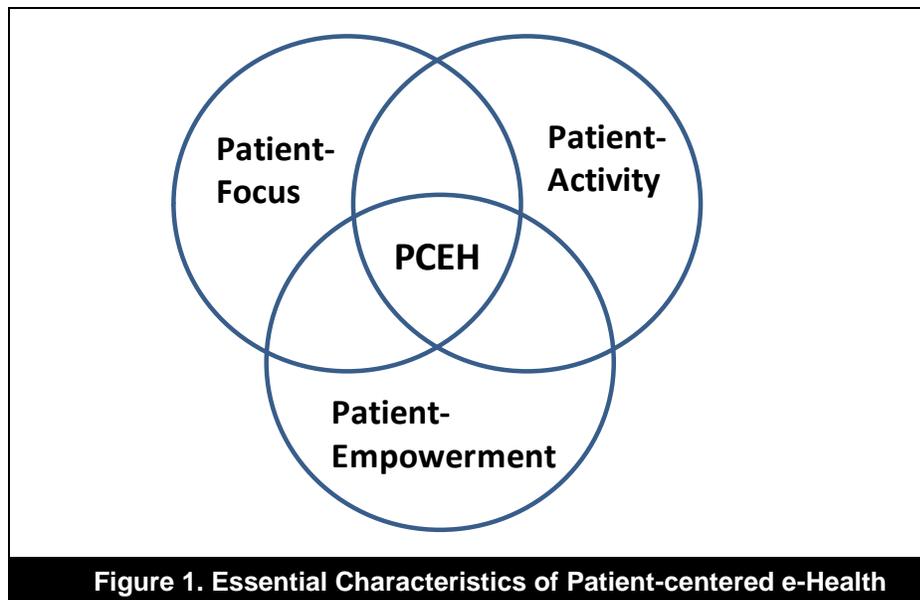


Figure 1. Essential Characteristics of Patient-centered e-Health

In this article, we empirically validate PCEH and operationalize its three aspects (Patient-focus, Patient-activity, and Patient-empowerment) in terms of different website features. We then develop a classification model based on those features. This article helps to answer such questions as the following:

- What can patients expect from the Internet in terms of healthcare or health information?
- What value is being offered and solicited by patients and clinicians in different health products and services, and what different technologies are being used?
- How are patients empowered to manage their own health?

Answers to these questions will certainly vary by individual patient, condition severity, and other factors. PCEH helps us conceptually by describing (1) to what extent the patient is the primary focus, (2) in what healthcare activities the patient is directly involved, and (3) how empowered patients are in controlling the activities and using their health information. This article makes three primary contributions, based on PCEH.

1. It presents an empirical validation of healthcare and patient-focused websites examined within the PCEH framework.
2. It identifies and analyzes five categories of healthcare websites: Consultation, Records, Monitoring, Information, and Community.

3. It defines a set of website features and proposes a classification model based on the features to correctly classify 79 percent of the websites.

We start by describing the three aspects of PCEH and raising some questions within each aspect.

### **Patient Focus**

Although PCEH websites are necessarily focused on patients, they may also serve other stakeholders. That is, patients may be one key stakeholder, but not the only one. The patient-focus may be secondary to the interests of other stakeholders in the healthcare system: physicians, nurses, laboratory technicians, hospital administrators, etc. Are the websites (and linked systems) a free service provided to engage patients, who may pay for additional services? Are the websites an investment in educating patients to encourage preventative care and decrease population management costs to satisfy payers? If good health is its own reward, do patients simply not need financial incentives to use a website? The business models do vary widely, even for PCEH websites devoted exclusively to patients. This study examines a range of websites devoted primarily to patients.

### **Patient Activity**

PCEH websites serve different types of patient activities. A patient's acuteness of illness, emotional state, age, and other factors influence his or her activities. Patients with a chronic condition do activities different from those with an acute condition. The activities differ widely as well. For example, a patient with Alzheimer's disease may simply want to talk to someone [Payton and Brennan, 1999], not necessarily find a cure. Similarly, a patient with asthma may simply want to feel capable, not necessarily symptom-free [Sassene and Hertzum, 2009]. An obese child may be motivated to solve his problem before the obesity becomes a lifelong condition or lead to complications, e.g., diabetes.

Research has shown that usability, i.e., a system's ease of use, is extremely important, particularly for low health literacy users [Leimeister, Ebner, and Krcmar, 2005]. Ease of use, however, is predicated on having a useful system that the patient trusts, e.g., to have clinical assurance. Other research has also shown that personal and emotional components of trust need to be considered [Alaszewski and Brown, 2007]. Given that trust has been found to be a crucial factor in online commerce [Loiacono, Watson, and Goodhue, 2007; Pavlou, Huigang, and Yajiong, 2007; Ziegler and Golbeck, 2007], why is the signaling of clinical assurance not as prevalent in patient healthcare websites? Is trust in PCEH taken as a given, not to be questioned or even claimed? Must it be with healthcare practitioners one has already encountered face-to-face, or will people trust others in online communities as long as they have a health problem in common? Self-efficacy and affective factors are important variables of satisfaction with e-health services [Lankton and Wilson, 2007], which suggests that patient websites need to be well-designed, easy to use, and emotionally engaging.

Some patients help each other through online communities, offering first-hand experiences and advice for people with similar conditions. PatientsLikeMe, for example, helps patients connect with others, sharing advice and experience with new drugs undergoing clinical trials (<http://www.patientslikeme.com>). An online community can be helpful with chronic conditions, diseases without a cure, or desperate patients willing to take large risks in order to stay alive. Do patients trust other people having no medical education or those that they have never met? One common strategy to signal legitimacy and trustworthiness in websites is to display certification symbols, such as TRUSTe (certified privacy) or URAC (accredited health website). This study examines websites' features, including whether they signal clinical assurance.

### **Patient Empowerment**

From an information-centric view, many patients simply use the Internet as a way for being a more informed patient, armed with better background knowledge prior to seeing a doctor face-to-face [Cline and Haynes, 2001]. Increasingly, clinicians engage and empower patients over the Internet with text, audio, or video communication technology. Some clinicians use advanced technology to monitor patients' chronic conditions, e.g., diabetes management at Partners Healthcare's Center for Connected Health (<http://www.connected-health.org/>). Such an approach educates and empowers patients to manage their own conditions.

Healthcare organizations use websites for many different reasons and purposes. Some use real-time technology, e.g., voice or video chat. Many PCEH websites signal that they are compatible with Personal Health Records (PHRs), such as that provided by Microsoft. Patients have been slow to adopt PHRs for maintaining their health information, however. Is that because of the lack of clinical, one-on-one assistance [Davidson and Heslinga, 2007], financial incentives [Kaelber, Jha, Johnston, Middleton, and Bates, 2008], or sufficient clinician trust in a data source that is patient-controlled?



In technology offerings, many health websites offer hardware or services, or promote standards. Some are offering middleware or software, and many health organizations are offering multiple types of technology. We see that a large proportion of consumer health websites emphasize mobility, perhaps through specialized hardware devices or general-purpose devices, e.g., smartphones and tablet computers. Access and ubiquity seem to be the current trend. This study examines various ways that websites empower patients with information and technology.

## II. METHODS

In order to better understand the healthcare websites, we formed a list of healthcare websites to examine some of the above questions. Because there was no definitive list of healthcare websites, we had to develop our own. First, we identified popular media resources of e-health websites, such as publishers and healthcare-focused newspapers and journals. Based on these resources, we collected published articles, Forrester reports, and newspapers to form an initial list of the healthcare websites. Then we followed the snowball method [Goodman, 1961] to identify more websites by checking the existing websites on the list. Many e-health websites provide “affiliated links” to show other websites with related health services. In this way, we formed a relatively comprehensive list of healthcare websites.

We then conducted a preliminary analysis. Three researchers independently examined each website for its validity and eliminated some websites as irrelevant. Since our study was to examine the websites providing services or applications to patients, we eliminated the websites developed by technology vendors that focus on selling their products to businesses, as well as medical consultancy websites that focus on providing solutions to business clients. The collection of websites grew to seventy before we removed irrelevant cases, e.g., technology vendors or medical consultancies, resulting in a final list of sixty-two health websites.

Using the three characteristics of PCEH, we discovered five types of consumer healthcare websites in the final list, which are all grounded in the academic literature:

1. *Consultation: real-time online communication with a doctor or other clinician.* Clinical consultations via the Internet can provide real-time communication for patients with one or more clinicians, e.g., Telemedicine or Telehealth [Perednia and Allen, 1995; Tulu, Chatterjee, and Maheshwari, 2007]. It has been used successfully in communicating images among radiologists in a thirty-two hospital network [Bailes, Poole, and Manni, 1997]. Research has found virtual visits similar to face-to-face ones, according to both patients and clinicians, on commonly presented problems, such as time spent with the physician, ease of interaction, and personal aspects of the interaction [Dixon and Stahl, 2009].
2. *Records: structured, digital records of an individual's health information.* Health records are typically kept for documenting information about a patient, including prior conditions, treatments, and allergies, e.g., Medconnect.com. Electronic Health Records (EHRs) hold promise for capturing, analyzing, and communicating the information between clinicians over time. Although privacy concerns may inhibit patient adoption [Angst and Agarwal, 2009], meaningful use requirements and incentives have been instrumental for increasing adoption in hospitals and large medical practices. PHRs are under the full control of patients, allowing them to input and manage their own health information. Although potentially empowering and leading to self-care and collaboration with clinicians, their adoption is unclear. Kaelber et al. [2008] have called for greater research and investment in PHRs.
3. *Monitoring: frequent communication of an individual patient's health indicators.* Remote monitoring of patients for life-threatening conditions, e.g., hypertension [Bosworth, Olsen, McCant, Harrelson, Gentry, et al., 2007] and heart failure [Chaudhry, Barton, Mattera, Spertus, and Krumholz, 2007] has been successfully established for technical and clinical feasibility. Patients can also be monitored for lower risk conditions, e.g., diabetes and acne management, sunscreen adherence, and exercise regimens [Bickmore, Mauer, and Brown, 2009]. Some research shows that such low-risk monitoring needs to be framed not as constant privacy invasion, but instead as a tool for personalized, longitudinal self-awareness and learning [Beaudin, Intille, and Morris, 2006].
4. *Information: general information about diseases, conditions, or wellness.* General health information is readily available online from many sources, with much of it at no cost, for the information-seeking patient. Government agencies, such as the National Institutes of Health, private businesses, e.g., WebMD, and nonprofits, such as the Mayo Clinic, educate the curious patient on an extensive range of health information topics. Patients can actively seek relevant information for their own references. There is no lack of health information online. The challenge for patients, it seems, is to identify the more clinically assured websites, absorb the appropriate information, and use it wisely.
5. *Community: online gatherings of people having a similar health interest or condition.* Online communities support patients having conditions ranging from mild to life-threatening [Snyder, Johnson, and McGowan, 2008]. For example, PatientsLikeMe.com enables online support communities in thousands of health



conditions. Patients help each other by providing information about treatments, sharing advice, and providing emotional support [Arora, Finney Rutten, Gustafson, Moser, and Hawkins, 2006; Kana'iaupuni, Donato, Thompson-Colón, and Stainback, 2005]. Whereas some websites host their social communities internally, some outsource it, e.g., to their Facebook pages.

The three researchers independently classified each website into one of the categories. A cross-validation was performed and thorough discussions were carried out to resolve any disagreements. After several rounds of discussions, an agreement was reached and the five categories of websites were finalized. See Appendix A for the list of websites and categories.

We proceeded to examine the similarities and differences among these types of websites. Based on multiple rounds of discussions, we developed several criteria to distinguish the above healthcare websites:

- Clinical assurance: indicates whether the website contains certifications, awards, rankings, or doctor references to support its credibility
- Voice/video communication: indicates whether the website provides online chat, phone chat, or live video conferences
- Web 2.0: indicates whether the website provides a Web 2.0 communication tool, e.g., Facebook or Twitter
- Asynchronous communication: indicates whether the website provides communication other than real-time communication
- Devices: indicates whether healthcare equipment is needed in order for the website to provide applications or services
- Clinical domains: indicates whether the website deals with a few or many diseases
- Frequency of contact: indicates how frequently the website interacts with customers
- Personal health record (PHR)/electronic medical record (EMR): indicates whether the website provides a PHR for patients and/or an EMR for clinicians
- Fees: indicates how the website charges its consumers when they use services or applications

By examining the websites based on these criteria, we were able to better understand the characteristics of these categories of websites.

### III. RESULTS

Sixty-two health websites were found, distributed across the five categories as follows:

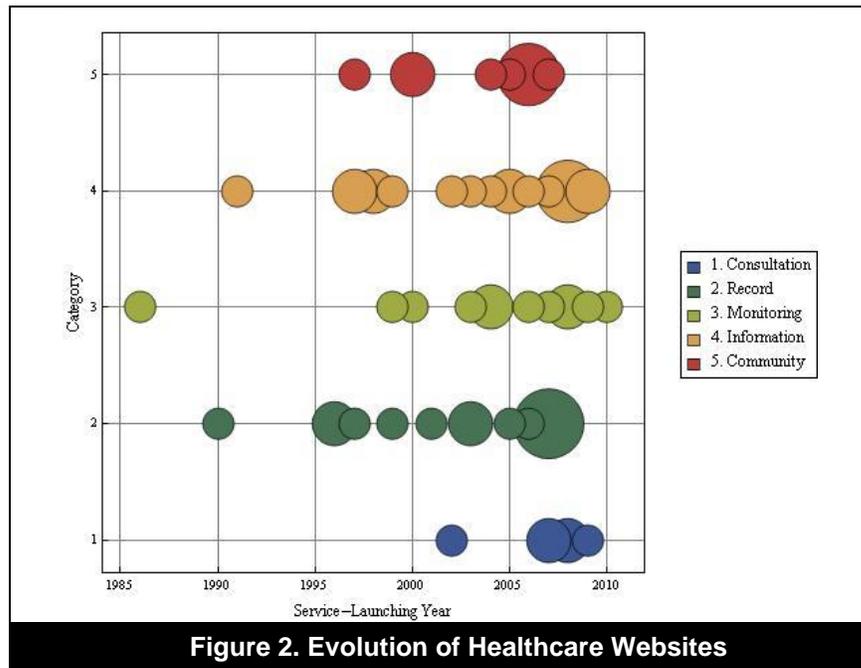
**Table 1: Five Categories**

	Consultation	Records	Monitoring	Information	Community	Total
Count (%)	6 (9.7%)	15 (24.2%)	12 (19.4%)	19 (30.6%)	10 (16.1%)	62 (100%)

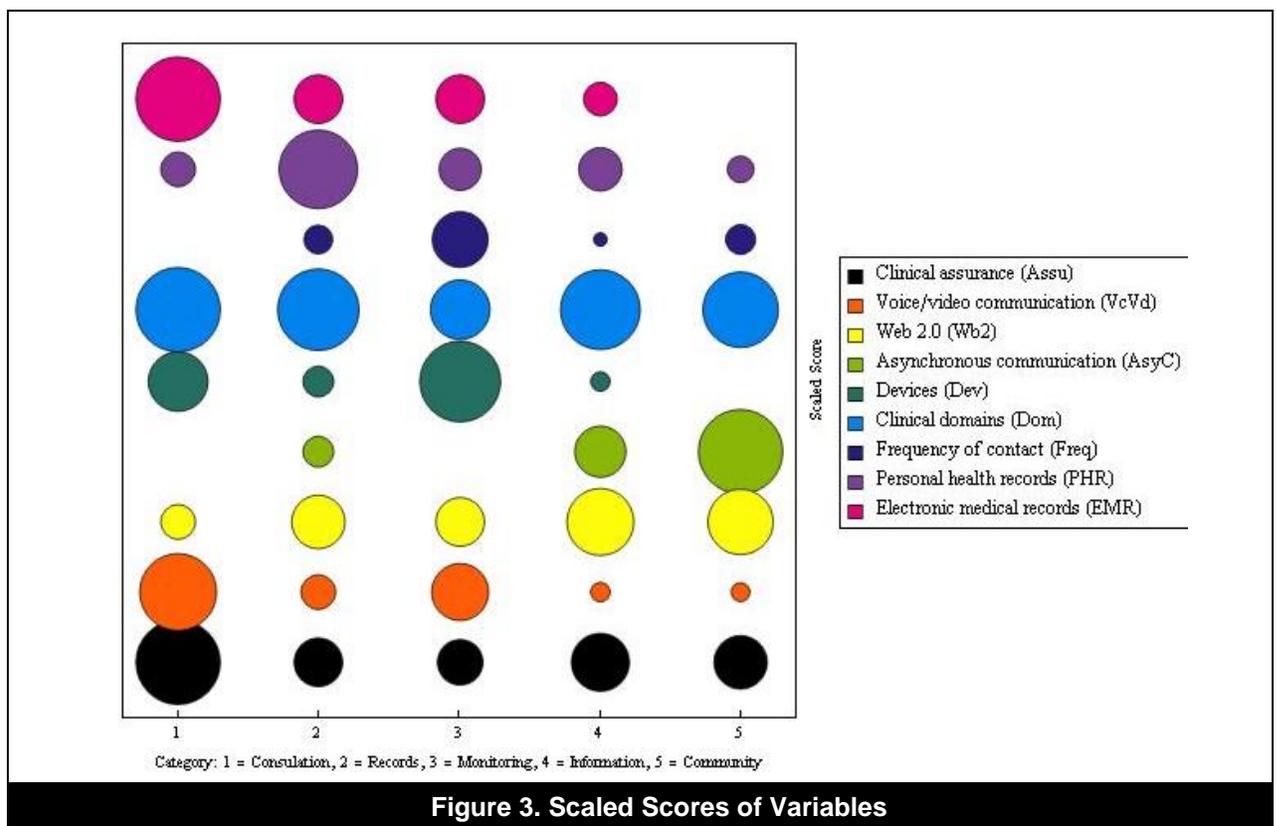
More than half of the websites are in the Information or Records categories. Consultation websites account for the smallest proportion and have a relatively short history. Based on our data, TeleDoc launched the first online medical consultation in 2002. Websites of the five categories have grown more common at different times, as can be seen in the bubble chart below.

Figure 2 shows the service-launching year of a website, which can be different from the founding year. In the Consultation category, for example, TeleHealth Connect was founded in 1986, but it launched online consultation services in 2007. The largest bubble of the Records category corresponds to five Records websites starting their Records services in 2007. The size of a bubble is proportional to the number of websites.

We can see online healthcare websites have been developing since the late 1980s. During the period of 1990–2000, Information websites played a major role, while Records websites with digital PHRs started to emerge. During the period of 2000–2005, TeleDoc was founded; this represents the starting point of online consultation. WebMD, as a new type of Information website, pushed services of Information websites to another level. Its marketing efforts made Information websites popular to the public. With low barriers to entry, many organizations interested in healthcare started to build their information-oriented websites. During 2005–2010, we entered the golden age of healthcare websites development. The majority of existing websites were founded after 2005.



To analyze the differences among the five categories, we collected data for all the variables. (See Appendix B for the detailed definitions of the variables.) In order to help distinguish the five categories, we calculate the *scaled score* of a variable for each category. Variables have different raw scores, and we convert them in scaled scores between 0 and 1. For each combination of variable and category, we first calculate the weighted average of the raw scores. The weight of a raw score is the number of websites having the raw score. Then, the corresponding scaled score is the weighted average divided by the largest raw score. Websites having larger raw scores yield a larger scaled score closer to 1. In Figure 3 below, each variable-category combination is shown as a bubble whose size is proportional to the scaled score. The figure shows significant variations in Clinical assurance (Assu), Voice/video communication (VcVd), Web 2.0 (Wb2), Asynchronous communication (AsyC), Devices (Dev), Clinical domains (Dom), Frequency of contact (Freq), and integration with PHR or EMR.



We found a number of differences across the five categories.

- Consultation websites are an online approximation of an actual clinic. They show the highest clinical assurance. Doctors are available in all Consultation websites, whereas websites in the other categories show alternative forms of assurance, e.g., awards, certificates, partnering, patient votes, and ranking. This category is also the strongest in voice/video communication, but asynchronous communication is not found and Web 2.0 is rare. Although all websites in this category use EMRs, PHRs are rare. Frequency of contact is the lowest.
- Records websites are the strongest in the use of PHRs, which enable any user to have access and control over their records. The use of EMRs is rare. Due to privacy and control issues, EMRs are mainly for doctors and other clinicians, which can be seen in the Consultation category having a scaled score of 1. We note that users in ten of fifteen Records websites include both patients and clinicians.
- Monitoring websites are the strongest in the use of devices. Frequency of contact is daily or greater, e.g., real-time, while infrequent contact is prevalent in the other four categories. Voice/video communication is more common, whereas asynchronous communication is not available. This category deals with a smaller number of clinical domains relative to the other categories. We note that clinical assurance is the lowest, even lower than that of Community. In Monitoring websites, doctors are not available. This is the opposite of Consultation websites, all of which have doctors available. This is one of the main differences between the two categories. Nevertheless, monitoring services are provided by qualified professionals and the design of monitoring processes needs a high level of clinical assurance.
- The Information category is strong in the use of Web 2.0, clinical assurance, and asynchronous communication. Voice/video communication and devices are rare. The frequency of contact is very low.
- In the Community category of websites, asynchronous communication is prevalent. This category is strong in the use of Web 2.0. Voice/video communication and PHRs are rare. No devices or EMRs are available.

We found three types of fees: setup fee, membership fee, and fee for service. Setup fees are incurred typically one time for opening a new account and installing service-related software whereas membership fees are charged periodically (e.g., monthly or annually) for maintaining an account. Fee for service (e.g., co-payment) is charged as needed whenever services are rendered. Fee structures are different across the five categories. We calculated scaled scores and illustrated them as bubbles below, showing variations in fee structure:

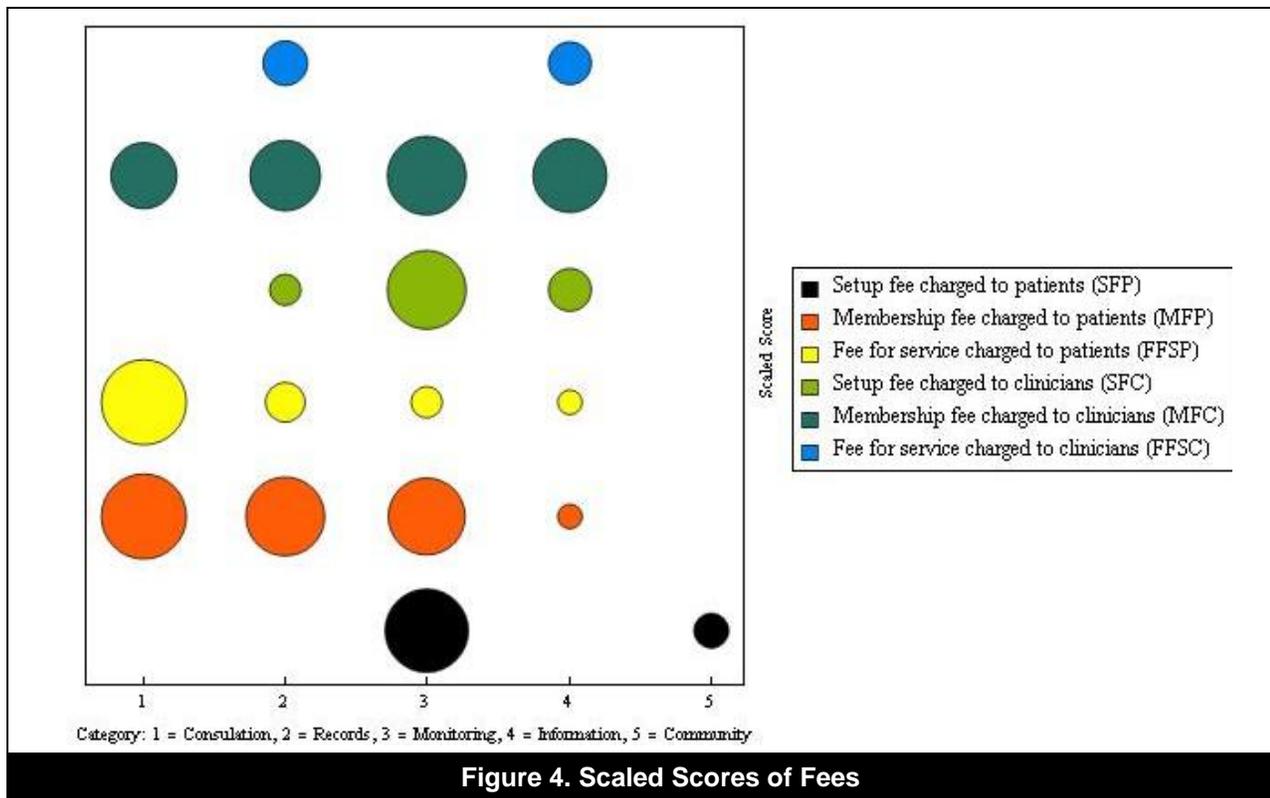


Figure 4. Scaled Scores of Fees

Some observations on fees are summarized below.

- Consultation websites charge membership fees to patients and clinicians. Fees for service are charged to patients only.
- Records websites charge membership fees and fees for service to both patients and clinicians. Setup fees are rare.
- Monitoring websites charge setup fees and membership fees to both patients and clinicians. Fees for service are rare.
- Information websites rarely charge fees to patients. Most of the charges to clinicians are membership fees, but some of them are setup fees or fees for service.
- No fees are incurred in Community websites, except for one-time setup fees to patients. Information and Community websites generally charge a smaller fee.

Table 2 shows PageRank, Google’s indicator of hyperlink connectedness, for the five categories. Higher PageRank could be because of a longer period of operation and exposure, more useful features/functions, or greater social popularity. It is interesting to note that Information and Community websites have more hyperlinks pointing to their websites, whereas Consultation websites have lower PageRank (<http://en.wikipedia.org/wiki/PageRank>).

Table 2: Average Page Rank by Website Categories					
	Consultation	Records (2)	Monitoring (3)	Information (4)	Community (5)
PageRank	3.6	4.4	4.3	5.5	5.7

We further performed a discriminant analysis to see how well we could distinguish one website from another. Discriminant analysis is a statistical method used to find a *linear combination* of *features* which characterizes or separates two or more classes of objects or events ([http://en.wikipedia.org/wiki/Linear\\_discriminant\\_analysis](http://en.wikipedia.org/wiki/Linear_discriminant_analysis)). It has been used widely in Information Systems research, including adoption of an information technology innovation [Moore and Benbasat, 1991], institution-based trust [Pavlou and Gefen, 2004], and new analytical techniques [Chin, 1998]. We aimed with discriminant analysis to determine which of our variables could differentiate the websites accurately and parsimoniously into different categories.

The discriminant chart (see below) is based on ten (10) variables: Assu, Wb2, AsyC, Dev, Freq, PHR, MFP, SFP, FFSP, FFSC. The five categories are represented as 1–5 as follows: Consultation (1), Records (2), Monitoring (3), Information (4), and Community (5). Monitoring (3) is quite different from the others.

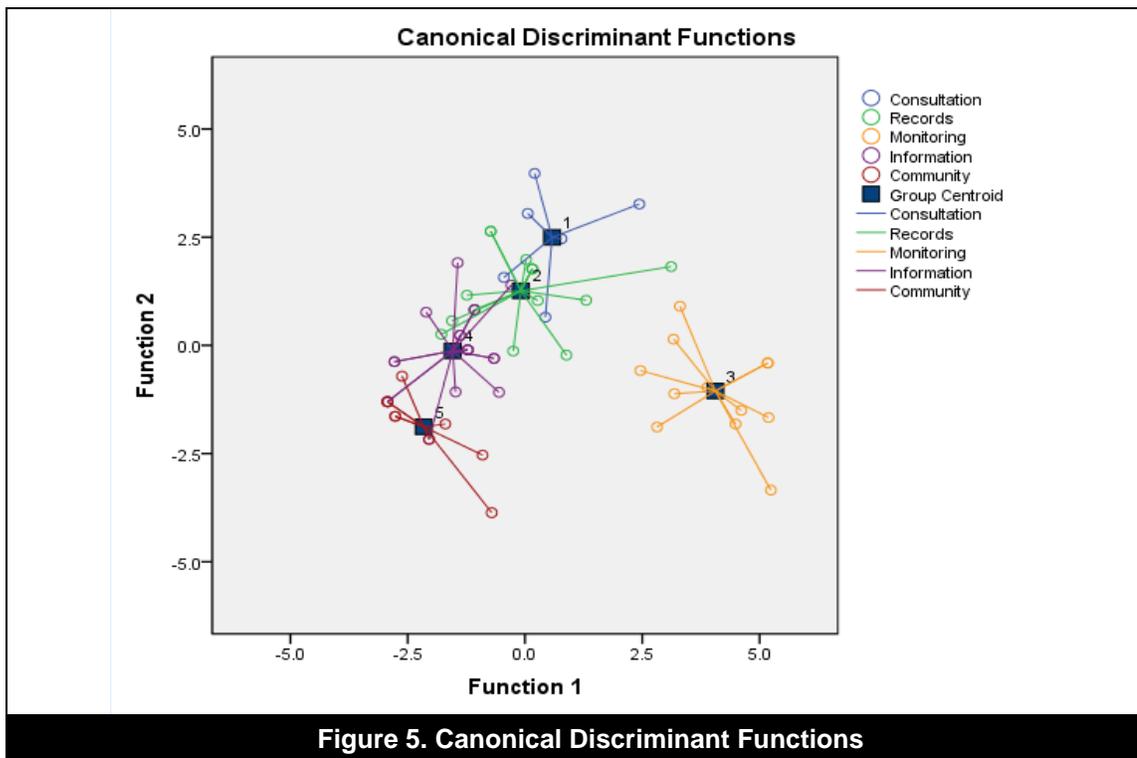
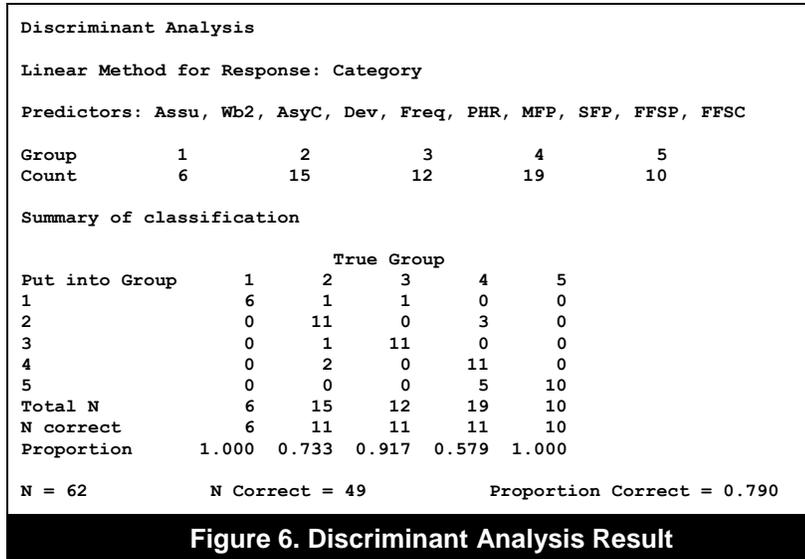


Figure 5. Canonical Discriminant Functions

In Figure 5, two linear functions based on the above ten variables are used to best distinguish the five categories. The linear functions are analogous to regression equations in which each variable is weighted by a coefficient. Taken together, the ten variables in the discriminant analysis correctly classify 79 percent of the websites.



The misclassified websites are the following thirteen.

Table 3: Misclassified Websites			
ID	Website	True Group	Predicted Group
1	Athenahealth	Records	Information
2	My Mood Monitor	Records	Information
3	Quest Diagnostics	Records	Consultation
4	Smart PHR	Records	Monitoring
5	Phillips PT/INR Self Testing at Home	Monitoring	Consultation
6	Cleveland Clinic	Information	Records
7	DoubleCheckMD	Information	Community
8	Everyday Health	Information	Community
9	Health Butler	Information	Records
10	HealthCentral	Information	Community
11	My DailyApple	Information	Records
12	OrganizedWisdom	Information	Community
13	TrialX	Information	Community

Information is responsible for two (2) occurrences of misclassification, Records: three (3) occurrences, Community: five (5) occurrences, Consultation: two (2) occurrences, and Monitoring: one (1) occurrence. This shows mostly a pattern of misclassification due to an error of specificity. Records are a specific type of information, particular to a patient. Some of those Records websites also provide general health information, in addition to the records. In addition, there is overlapping of categories. The misclassified occurrences tend to be Information websites that the discriminant analysis predicted to be Community websites. This may indicate a notable trend that Information websites are adding community features, making it difficult to distinguish the two categories. That is, Information websites are increasingly incorporating community functionality, e.g., blogs, message boards, or threaded discussions.

#### IV. DISCUSSION

Based on the above results, we can see that each category of these healthcare websites does have some unique features. We further rated these websites according to the three characteristics of PCEH framework (See Table 4 below).

The three characteristics of PCEH (focus, activity, and empowerment) are interrelated [Wilson, 2009; Wilson, Wang, and Sheetz, 2014]. Yet they also happen to vary across the five categories we discovered. We observe that the five categories of health websites incorporate the three aspects at different levels.



**Table 4: Three Characteristics Rating on the Five Websites Categories**

	Patient Focus	Patient Activity	Patient Empowerment
Consultation	High	Moderate	Moderate
Records	High	Low	Moderate
Monitoring	High	Moderate	Moderate
Information	Low	Moderate	High
Community	Moderate	High	High

Consultation websites are highly patient-focused. Having high clinical assurance, they cover a large variety of clinical domains for patients' consultations. These websites are equipped with advanced communication technologies to enable patients to receive healthcare services via an online clinical consultation. This unique patient activity distinguishes this category from the others. Many Consultation websites offer PHR self-management and real-time communications with doctors/hospitals. The patients have full control of their PHRs, including setup, maintenance, and sharing decisions. Patients of these websites decide when, where, and from whom to consult their health issues.

It is worth noting that the setup of digital records is a major step in order for the healthcare industry to fully move online. Interestingly, similar to patients visiting local clinics, patients of Consultation websites are charged co-payments. In addition, many of these websites also charge membership fees to patients, similar to insurance expenses. With network technology advancing quickly, online consultation could be considered a good alternative mechanism to deliver healthcare services and health information. These Consultation websites can provide a wide range of healthcare services and can empower patients.

Records websites are highly patient-focused. These websites are represented by their distinct PHR services and a large variety of clinical domains. Patients are enabled to self-manage their health records and gain access to them at any time. However, the patient activity is limited primarily to patient records management. Record websites charge membership fees primarily. Only one-third of Records websites provide EMR services in addition to a PHR. Due to privacy, reliability, or security concerns, and control issues, hospitals may prefer their in-house systems to manage their EMR rather than the use of a third-party provider. Perhaps once EMRs are supported by integrated IT architecture and Health Information Exchanges, they will be interoperable and may be outsourced by hospitals [Blechman, Raich, Raghupathi, and Blass, 2012; Venkatraman, Bala, Venkatesh, and Bates, 2008].

Monitoring websites are highly patient-focused. These websites are represented by high frequency of contact and use of physical devices. For certain medical conditions, these websites monitor patients continuously and collect their clinical data regularly. Although the patients are contacted frequently, they may not be able to communicate with clinicians via the websites to actively discuss their concerns. These websites do grant the power to self-check the recorded results online in some cases. However, the monitoring data kept at these websites are different from PHRs or EMRs, which are not widely used in these websites. These websites charge setup fees in addition to the regular membership fees.

It is clear that Information and Community websites share many similarities. The majority of these websites are patient-focused, with a few exceptions of Information websites providing health information to the clinicians as well. No websites in these two categories provide PHR or consultation services. Regarding a fee model, the majority of them do not charge any fees. To clinicians, Information websites charge low membership fees and Community websites charge no fees.

Both Information and Community websites cover a variety of clinical domains and maintain Web 2.0 tools for communication among patients. Compared with other categories of websites, both categories are more active in adopting new communication technologies, e.g., Twitter or Facebook. These new communication tools dramatically empower the patients to self-diagnose health problems, communicate their concerns, seek help or comfort, and exchange information with other patients in various ways. These easy-to-use services satisfy different needs of many patients. The only major difference between these two categories lies in the communication method: Community websites facilitate inter-member communications by using blogs, message boards, etc., while Information websites emphasize one-way communications to patients.

**V. CONTRIBUTIONS AND CONCLUSION**

This is, to the best of our knowledge, the first empirical validation of patient-focused healthcare websites examined within the PCEH framework. It is also the first to identify and analyze the five categories of healthcare websites. We analyzed the five categories in terms of different features and derived a classification model. Below are the three primary contributions of this article.

First, we presented an empirical validation of patient-focused healthcare websites examined within the PCEH framework. The results of this study confirm that the three aspects (Patient-focus, Patient-activity, and Patient-empowerment) of PCEH serve as a conceptual framework for the analysis of these websites. Each of the five categories of websites shows the three aspects to different degrees.

Second, the rising demand of outpatient healthcare services places additional demand for the implementation of new healthcare and health information services [Pratt, Unruh, Civan, and Skeels, 2006]. This study identified and analyzed five categories of healthcare websites: Consultation, Records, Monitoring, Information, and Community. These findings can promote the awareness of the existing websites and allow patients to make full use of their different services.

Third, this study defined a set of website features and a classification model based on the features to correctly classify 79 percent of the websites. This classification model can help providers to clarify their goals and guide the development of the websites. The findings can help patients understand the different features of healthcare websites.

By examining the history of these websites, we foresee that Information and Community websites will continue to be strong in increasingly rich communication channels. In addition, since the recently developed Consultation and Records websites provide new ways to receive clinical treatment and manage patients' records, we predict they could be a trend in the future development of healthcare websites. When more doctors and hospitals get involved, online consultation can be a good alternative resource to treat non-acute sickness or to seek second opinions.

Our findings suggest that each category shows distinct features. In order to serve patients better, websites in each category need to emphasize their own strengths:

- Consultation websites need to clearly promote strong clinical assurance, for example, by describing the doctors' background and experience, to gain the trust of the patients. A wide coverage of clinical domains and EMR systems are useful in building a successful website. Low co-payments and membership fees would attract more patients.
- Records websites need to continue focusing on PHR, while extending EMR services to hospitals. The integration of PHR with hospital EMR and Health Information Exchanges could be a strong future development in healthcare [Pratt, Unruh, Civan, and Skeels, 2006].
- Monitoring websites need to promote clinical assurance embedded in their processes, the advantages of their devices, and the necessity of monitoring services for particular clinical domains, e.g., diabetes.
- Information websites should focus more on the active delivery of valuable information to the patients through communication tools. The adoption of social network tools, such as Facebook and Twitter, could be the focus of these websites.
- Community websites should adopt more interactive communication tools to allow intra-group communications. For example, it might be useful to allow patients to leave voice or video messages online for other members. The receivers then could access the messages online or through their mobile devices.

Although this study helps to enrich our understanding on the PCEH framework, limitations do exist. Since the number of patient-focused healthcare websites continues to increase, our sample may not include all the viable websites. This omission may be attributed to the expediency of snowball sampling method [Birnacki and Waldorf, 1981]. However, with a sufficient number of websites in each category, we believe that our sample represents the current state of e-healthcare website development. We also hope that follow-up longitudinal studies revisit our findings after a certain period of time.

Our research explored the features of these websites in five different categories. There are many research questions remaining for future studies: How can organizations develop their services to attract more patients? With the significant rise of healthcare expenses, how can they develop an effective fee structure? Business models are still evolving, trying to provide quality care and health information at low costs. How can they do so while truly empowering patients?

Given that mobility is an important offering, what are the different effects of healthcare services on different classes of healthcare consumers who have limited mobility, e.g., elderly patients or injured war veterans? Are mobile or smart phones sufficient, as some research has found [Logan, Mclsaac, Tisler, Irvine, Saunders, et al., 2007], or is a personal computer significantly better? What about personal computers without broadband [Watson, Bell, Kvedar,

and Grant, 2008]? What is the role of websites when software applications are proliferating on mobile devices [Logan, McIsaac, Tisler, Irvine, Saunders, et al., 2007]?

Our study attempts to provide some preliminary findings on these important questions. With more advanced technology, more patients will explore online resources for healthcare and health information services.

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*Editor's Note:* The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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## APPENDIX A: LIST OF ANALYZED HEALTHCARE WEBSITES

American Well	1–Consultation	Phillips Telestation	3–Monitoring
AmeriDoc	1–Consultation	Viterion TeleHealthcare	3–Monitoring
Consult A Doctor	1–Consultation	Cleveland Clinic	4–Information
EasyHealthMD	1–Consultation	CVS	4–Information
TelaDoc	1–Consultation	DoubleCheckMD	4–Information
TeleHealth Connect	1–Consultation	ePocrates	4–Information
Athenahealth	2–Records	Everyday Health	4–Information
MediConnect	2–Records	Harvard Pilgrim Health Care	4–Information
MediKeeper	2–Records	Health Butler	4–Information
miCard	2–Records	HealthCentral	4–Information
MS HealthVault	2–Records	Heart Profilers	4–Information
My Mood Monitor	2–Records	HeartHub for Patients	4–Information
myHealthfolio	2–Records	iMedSource	4–Information
MyMedicalRecords	2–Records	Mayo Clinic	4–Information
MyVitalData	2–Records	My DailyApple	4–Information
NoMoreClipboard	2–Records	OrganizedWisdom	4–Information
Quest Diagnostics	2–Records	RxCut	4–Information
Smart PHR	2–Records	Stay Smart Stay Healthy	4–Information
SPINN PHR	2–Records	TrialX	4–Information
Training Peaks	2–Records	UpToDate	4–Information
Unival yourHealth	2–Records	WebMD	4–Information
Bosch Healthcare	3–Monitoring	CarePages	5–Community
Cardiocom	3–Monitoring	DailyStrength	5–Community
Cardionet	3–Monitoring	HealthBoards	5–Community
GrandCare Systems	3–Monitoring	iMedix	5–Community
Halo Monitoring	3–Monitoring	Inspire	5–Community
Healthanywhere	3–Monitoring	MDJunction	5–Community
Healthsense	3–Monitoring	PatientsLikeMe	5–Community
Lifeclinic	3–Monitoring	PEERTrainer	5–Community
Nonin Medical	3–Monitoring	Sermo	5–Community
Phillips PT/INR Self Testing at Home	3–Monitoring	SparkPeople	5–Community

## APPENDIX B: VARIABLES AND THEIR DIFFERENT LEVELS/VALUES

1. Clinical assurance (Assu): 0 = none, 1 = awards, certificates, partnering, patient-votes, highly-ranked, 2 = doctors available
2. Voice/video communication (VcVd): 0 = none, 1 = use of live conversation using phone or voice chat, 2 = use of live conversation using video conferencing
3. Web 2.0 (Wb2): 0 = none, 1 = links to social media/Web 2.0 communities
4. Asynchronous communication (AsyC): 0 = none, 1 = postings, blogs, bulletin boards
5. Devices (Dev): 0 = none other than computer and telephone, 1 = hardware peripherals excluding computer and telephone)
6. Clinical domains (Dom): 0 = one or a few clinical domains, 1 = many
7. Frequency of contacts (Freq): 0 = irregular or initiated by patients, 1 = weekly, 2 = daily, 3 = hourly, 4 = real-time

8. PHR: 0 = none, 1 = personal health records
9. EMR: 0 = none, 1 = electronic medical records
10. SFP: 0 = none, 1 = setup fees charged to patients
11. MFP: 0 = none, 1 = membership fees charged to patients
12. FFSP: 0 = none, 1 = fees for service charged to patients
13. SFC: 0 = none, 1 = setup fees charged to clinicians
14. MFC: 0 = none, 1 = membership fees charged to clinicians
15. FFSC: 0 = none, 1 = fees for service charged to clinicians
16. PageRank (PageRank is a link analysis algorithm that measures the relative importance of a Web page. Ceteris paribus, pages that have more hyperlinks pointing to them have higher PageRanks, whereas pages with fewer hyperlinks pointing to them have lower PageRanks. If there are no links to a page, there is no PageRank for it.)

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