Medical informatics in the Web 2.0 era

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Abstract. The main role of medical and healthcare informatics is the manipulation of medical information and the dissemination of knowledge. The advent of the Web increased the pervasiveness of medical information and attracted the interest of both practitioners and patients. Web 2.0 in its turn brings people together in a more dynamic, interactive space. With new services, applications and devices, it promises to enrich our web experience, and to establish an environment where virtual medical communities may flourish away from private interests and financial expectations. This article performs a bird's eye view of Web 2.0 novelties, portrays the structure of a medical community and describes how medical information can be exploited in favor of the community. It discusses the merits and necessities emanating from various approaches and tools and gives emphasis on the intelligent information management inside the medical community.

Keywords: Web 2.0, Medical Communities, Services

1 Introduction

Medical informatics has been defined as the study and implementation of structures to improve communication, understanding and management of medical information. The objective is the extraction, storage and manipulation of data and information and the development of tools and platforms that apply knowledge in the decision-making process, at the time and place that a decision needs to be made.

The advent of internet introduced the idea of tele-application of medical practices. Tele-medicine, tele-education of practitioners and nurses, tele-healthcare and tele-consultation are rapidly developing applications of clinical medicine, where medical information is transferred via telephone, the Internet or other networks for the purpose of consulting, and sometimes remote medical procedures or examinations.

Internet has broaden the scope of medical information systems and led to the development of distributed and interoperable information sources and services. In the same time, the need for standards became crucial. Federated medical libraries, biomedical knowledge bases and global healthcare systems, offer a rich information sink and facilitate mobility of patients and practitioners.

The Web attracted more patients and increased the popularity of freely available medical advice and knowledge. The abundance of web sites that offer medical content

affected the way patients face their doctors, gave them a second opinion and increased their awareness.

Its' successor, Web 2.0, was built on the same technologies and concepts but added a layer of ***semantic abstraction***, offered a network as a platform sensation and gave a ***social networking aspect*** to medical information systems.

Patients, instead of seeking medical information and requesting medical advice on their issues, are supplied with useful news, when medical advances take place. Patients are able to discuss their issues with other patients and collectively develop a medical knowledge base with easy to use tools. The plethora of tools and platforms available enhances the inventory of medical practitioners and can be of value to them and their patients if properly exploited. This paper gives an overview of these tools, discusses the merits of their use and the potential hazards that should be avoided.

In the following section we enlist the major technological novelties of Web 2.0 under the prism of certain applications. In section 3 we examine a community based approach, which combines the aforementioned novelties, under the prism of intelligent information management and in section 4 we discuss the potential merits of this approach and the issues that should be considered.

2 Web, Web 2.0 and medical applications

Internet and its services had a major impact on health care and medical information. First, it opened public access to medical information, which was previously restricted to health care providers. Of all searches on the Internet, 4.5% have been calculated to be health-related [7]. The patients feel empowered before reaching their doctors [1], since they found or ask for information on the web. They get an idea about their diagnosis and treatment options and want to actively participate in therapeutic decisions. As a result, the way of interaction between the patient and the doctor, has changed. Similarly the way people perceive medical information has changed.

2. 1 Medical information and web-based applications

The seek for direct medical consultation gained place from searching and browsing of medical information and this is another fact of change in the way of communication between doctors and patients. "Ask the doctor services" [17], initially deployed through e-mail, kept record of questions and replies by expert physicians and published results to the web for further reference [18]. Web sites have been also created in order to alert or support patients [8] and offer informative content, provide directions for prevention, cure and symptoms' handling and of course sample questions and feedback from physicians.

Electronic assessment is another healthcare application which gained great attention. Online questionnaires, symptom checklists etc. were used in order to increase the interactivity of web based medical applications. Short screening tests [9], [14], helped people to detect and overcome their addictions, alerted them and reminded them to visit their doctor. Mailing lists was also a solution for supporting patients in a constant manner.

Table 1 summarizes medical applications and services delivered over the web.

Web applications	Purpose	Services
Ask the doctor	Offer medical consultation on demand	E-mail
Medical chats	Offer medical consultation on demand, group therapy	Chat
Medical forum	Offer medical consultation on demand, retain archive	Forum
Ask the doctor website	Archive medical consultation	Dynamic Web site
Patient support websites and mailing lists for alerts	Provide informative content, support and prevention guidelines	Email, Static Web site
Online assessment	Prevent maladies, detect additions	Active Web Site
Tele-healthcare, medicine, homecare etc.	Remotely provide clinical care, diagnosis, medical education	Tele-conference, Voice and Video over IP

Table 1. Web based medical services

Tele-healthcare, tele-medicine [10], tele-homecare and other applications make use of Web and the whole Internet infrastructure in order to offer clinical and non-clinical services (medical education, information and administrative services).The main aim of these application is the transfer of medical information and advices between the hospital and the remote patient, or the remote care provider, thus removing geographical and time zone barriers. In the same direction, interoperable medical information systems have been developed to support exchange and utilization of medical information across different hospitals, different healthcare providers or even across different countries [3], [2]. Web is mainly employed to achieve better coordination of all the participants in the medical process.

All the above applications created a critical mass of people, practitioners, patients, care providers and care givers that requests medical information and advice in health related issues in an everyday basis. People assembled virtual communities around their issues and started seeking for more flexible and collaborative solutions. The interest for ubiquitous medical information and pervasive solutions [4], created new web applications that facilitate people in sending, processing and receiving medical information. At the same time a lot of Web 2.0 applications and standards emerged.

3 Collaborative services and Medical communities

Despite the achievements of web and its services, it was necessary that patients seek for medical information and that patients contact their doctors for consultation, diagnosis or treatment. The advent of Web 2.0 changed this uni-directional flow of information. Now, all community members, even patients are able to feed the community with news, advices and personal experiences. Moreover, the request-serve model has changed towards a push-pull model where information is accumulated by community members and is made available to them through intelligent services (see Figure 1). Patients receive useful alerts and doctors get notifications on medical advances, new medicines and therapies.

In [13], the term Web 2.0, is perceived to encompass a set of services, which extend Web 1.0 capabilities and emphasize on the community and collaboration aspects. In [15] and [16] authors present how medical communities can be used in favor of patients and how communication and collaboration between members of the healthcare community can be hosted in a community platform

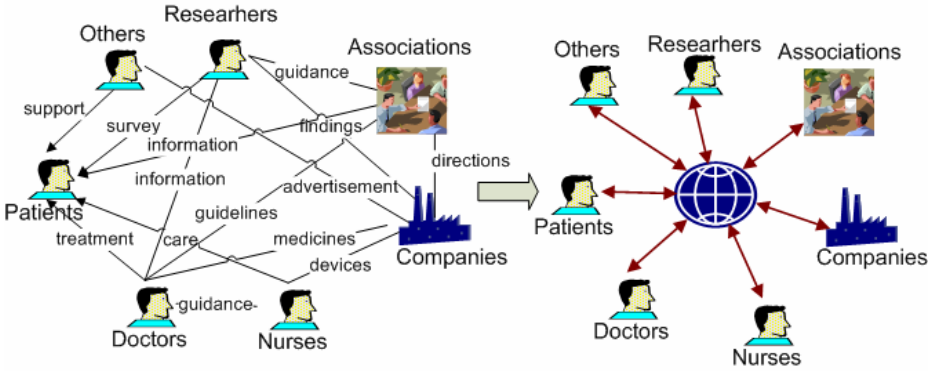

Figure 1 How the medical mesh transforms into a community

3.1. Web 2.0 Services

There is already an important amount of Web 2.0 applications [5], [6], [11], [12], which are related to medical issues. Blogs, wikis, folksonomies, podcasts and vidcasts are among them. In the following we give details on these applications, on the way information is published, annotated and consumed and on their potential use in favour of the medical community.

The main characteristics of all Web 2.0 services, which are presented in Table 2 are: a) contribution is communal, b) publishing has been replaced by participation and c) access is public or at least is granted to the members of the medical community. Anonymity and identity issues are solved with the use of virtual identities. They are mainly asynchronous since it is infeasible for all community members to be concurrently online.

Blogs

Blogs (WeBLOGs) are Web sites that function as online journals. They present published content in reverse publication date blogs. One or more persons may contribute with articles (posts), comments, links to other Web sites and multimedia content. Blog participants form virtual groups based on their common interests in the blog's topic. The easy and immediate publishing made them very popular. The posting of a clinical photo from a digital camera or a mobile phone directly to a blog after optimisation and commenting can be made at the touch of a button. Medical blog examples include Clinical Cases and Images, Family Medicine Notes etc.

RSS

RSS stands for "Really Simple Syndication." It is a standard format used to share content on the Internet. Many websites provide RSS "feeds" that describe their latest news and updates. They play the role of newsletters but offer information in pieces, at the moment it is created (feeds) and can be accessed by various devices and systems grace to the standard format. The doctors' lounge, RSS for medics and Medical News

Today are a few medical RSS news syndication services. Most blogging services offer the ability to create RSS feeds and an RSS reader is the only tool needed to process this feed.

Web 2.0 apps	Purpose	Online examples/tools
Blogs, photo blogs	Provide medical consultation, news, announcements, photos, allow comments	www.docnotes.net http://casesblog.blogspot.com
		www.wordpress.com www.flickr.com
RSS feeds and news syndications	Instantly receive medical information right after it is published	http://www.doctorslounge.com/rss http://www.rss4medics.com www.medicalnewstoday.com
		http://www.feedforall.com
Podcast and Vidcast	Provide consults, courses and information in audio and video stream format	http://conversations.acc.org/ http://www.annals.org/podcast/index.shtml http://www.clevelandclinic.org
		http://video.google.com/ http://www.archive.org/details/movies
Wiki	Collaboratively construct an archive of medical knowledge	http://askdrwiki.com/mediawiki/ http://www.radiopaedia.org
		http://www.mediawiki.org/ http://www.splitbrain.org/go/dokuwiki
Collaborative Tagging and Social bookmarking	Link to informative content, evaluate sources and organize knowledge	http://www.bibsonomy.org/ http://www.citeulike.org/
		http://www.flickr.com/ http://www.connotea.org/

Table 2 Web 2.0 applications. Examples and open source solutions

Audio and video podcasts

They can be employed similar to RSS for providing medical information on emerging issues. Moreover, the power of image and the ease of listening instead of reading make them ideal for the dissemination of medical information and for online courses. Example are: the Annals of Internal Medicine, the podcasts of the American College of Cardiology (Conversations with Experts) and the vidcasts of Cleveland Clinic.

Wikis

Wikis are considered to replace content management applications by allowing users to easily publish articles, images and video. They can start to cover the lack of free online medical information and function as a repository of medical information that could be readily accessed for reference. They are built and populated collaboratively by domain experts and are accessible to patients, doctors or trainees and the public. In a medical wiki, the group of editors creates and contributes with article reviews, disease definitions (symptoms, cure etc), clinical notes, medical images or video. Editors have the ability to alter content published by other editors and have their articles edited by others hoping that the wiki will finally converge into a widely accepted final version.

Social bookmarking

Medical bookmarking is aimed to promote the sharing of medical references mainly amongst practitioners and researchers. Scientists can share information on academic papers, are able to collaboratively catalog medical images with specific tools developed for that purpose. Article readers can organize their libraries, which can comprise Medline articles, with freely chosen tags. The result is a multi-faceted taxonomy, called folksonomy of tags (topics) and associated sources. Many medical information sources support tagging by users (i.e. JSTOR, PLoS, PubMed, and ScienceDirect). Human knowledge, captured in the categorization and characterization of articles, or web sources in general, can be exploited by intelligent agents in order to provide recommendations about related sources or tags.

It is obvious, that all the services presented above, differ from typical web services, in the multitude and nature of information sources they cover and the way of enhancing and exploiting this information.

3.2. The medical community structure

A medical community that will encompass all the people interested in medical issues should be open to new members. Trustfulness is critical in medical issues and specifically in medical consultation, so the identity of consultants has to be valid and accessible to the community members. In the same time, the anonymity is necessary (or at least helpful) for patients that seek for consultation.

Information/content providers and information consumers are the two main types of users. The former should necessarily use their real identities, whereas the latter can remain anonymous or behind use virtual personas. Information consumers (i.e. patients, people asking about medical issues etc) can potentially become providers, since their questions, remarks and bookmarks are made available to the community. However, the quality of this content is questionable. Moderators, administrators and facilitators stand in-between the two types of users and are responsible for the smooth operation of the community. They control the registration process and guarantee the validity of expert members' identities.

The community members are able to form groups inside the community based on common needs and interests. The needs of each group are different and sometimes contradictory. It is necessary for the community to allow members to communicate their similarities and join their forces, whilst protecting their individuality. A healthcare community can attract scientists and researchers, doctors and nurses, patients and people with personal interests in medicine and healthcare, companies. More specifically:

- Scientists and researchers join the community in order to exchange knowledge and promote their science. They communicate with patients, analyze surveys' results and population statistics and get useful feedback on patient needs, on medical issues that arise etc. They co-operate with other scientists for their experiments and disseminate their findings to companies and individuals. They also give useful directions to medical associations concerning public health.
- Medical associations provide the professionals with guidelines on patient treatment and inform patients on topics such as prevention, self protection

etc. They issue specifications for companies that produce medical devices and medications.

- Healthcare companies advertise their products (devices, therapies, medical applications) to doctors, nurses and patients.
- Healthcare practitioners get informed on new findings, emerging therapies and medical approaches and sometimes get online training. In parallel, they guide nurses and patients' families on patient-care and provide researchers and associations with useful feedback on emerging patient needs.
- Patients are ***receivers*** of support, treatment, care, information and advertisement from all other participants. They contribute to the community, as end users of the community outcomes and as specimens of surveys.

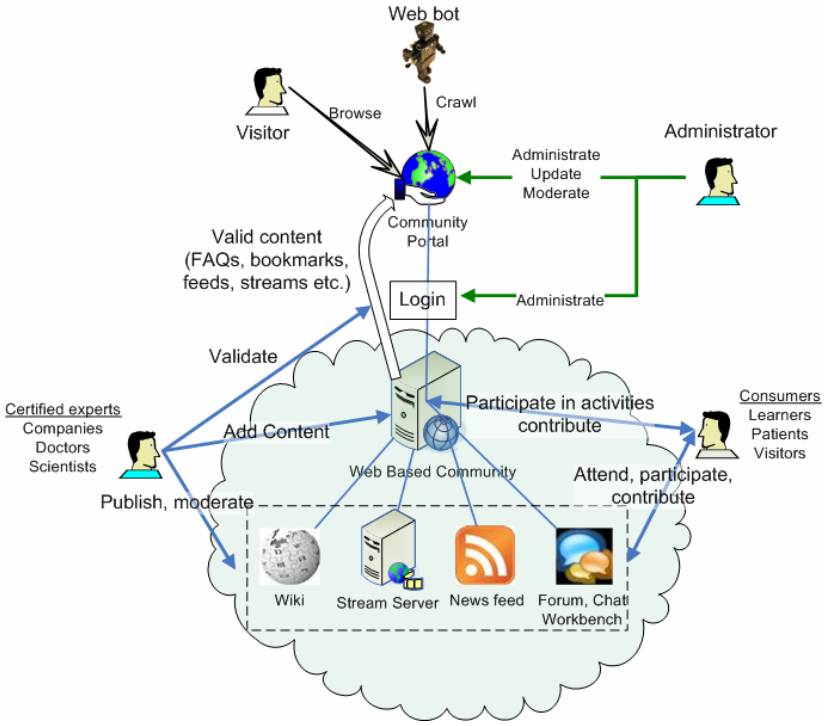

Figure 2. The medical community structure

As it is depicted in Figure 2, the medical community portal is accessible to every web visitor or bot that wishes to browse or process the published content. Community members, should register once and login every time they want to join the community. The registration of new members should be controlled by the administrators. The identity of expert members (doctors, company officials, scientists etc) should be checked and certified by the administrators, where as simple members can join by giving a contact e-mail address. Inside the community, registered users are able to participate in the various activities (i.e. chat with doctors or other members, perform public discussions, attend a video podcast or registed to news feeds). The community experts create and publish new content and are charged with the moderation of group

discussions, and the filtering of content uploaded by non experts. They use the wiki and tagging services to accumulate and organize the knowledge base of the community and inform on new findings using the news feeds.

4 Discussion

The merits that arise from the community approach are many. First of all the human knowledge is captured, is enriched with semantics (i.e. tags) and is organized collaboratively (i.e. folksonomies, wikis) in a mechanically readable way. Instead of a multitude of distinct applications that do not cooperate, the community platform is the World Wide Web, and the community activities and services can be developed using commonly agreed standards and common terminology. Web offers ubiquitous access to the community services, since web 2.0 applications are light and can be accessed by mobiles, PDAs, or even tv-sets. New content (i.e. video blogging or podcasting), requests for advice, patient related information or input to surveys can be attached using the same devices (e.g. patient can select their symptoms from a list and communicated them to the community experts).

The personalization of the community content to the specific needs of each member can be done by selecting the mini-applications (widgets) that fit each patient's needs. Smart alert systems can be developed that will remind patients of their scheduled treatment or that will inform doctors on their patients health status.

All community transactions and communications must be secure and various access levels can be used. Trust inside the community can be guaranteed by a strong administrator organization through the use of proper technologies, validation mechanisms and security structures. Trust can also be developed by using an evaluation and reputation system. In this system, expert users will be able to validate content, and all community members will be able to judge, vote and tag content in order to make it useful for others.

As it is the case with all communities, the administrators should be careful to avoid several dangers. Most of the efforts we mentioned in section 2, are made by individuals, or by a single institute or university and are not supported by a big organization or a medical forum. A centrally co-ordinated effort is necessary for a successful and effective community. Administration should be performed in co-operation with companies and associations. When the community serves for patients or doctors to support other associates, the advices and information exchanged between individuals should be validated. Group moderators need monitoring tools in order to proactively coordinate groups, and would be pleased to have collaborative platforms to support their groups. Validity can be achieved through monitoring, although, it is preferable to replace monitoring with an authorization mechanism. Advices, comments or opinions that are not signed are considered of low quality and consequently invalid. Valid information and services are issued by authorized community members only and are always signed.

The diversity of web 2.0 tools can be confusing to the community members, especially when all novelties are introduced in one step. Changes and new services should be added slowly and training, facilitation and user feedback are appreciated.

Another issue that must be considered in a medical community relates to the amount and quality of information offered. The flood of information can be confusing both to patients and doctors and as a consequence, information must be filtered and organized. Since anyone is able to publish information and since it is not always easy to see the origin of the information, users could be making decisions on the basis of a source that might not be quality assured. A certification authority is necessary to guarantee the expertise level of every user, control the quality of the published information and build trust among the community members. Even when the information is of high quality, users are not capable to make their own judgments and need support from the experts. Other issues relate to the expertise of all members in handling virtual discussions or providing diagnosis remotely. These issues should be considered in the design phase in order to increase members' participation and improve the quality of the community services.

5 Conclusions

This paper performed an overview of web 2.0 applications and compared their features to traditional web services under the prism of the medical community and its needs. Current attempts in using web 2.0 applications in favor of the medical community are disconnected, so we present a structure that will allow their interconnection. The community will bring together doctors, nurses and volunteers around patients and will provide the tools for requesting and providing medical information, advices and psychological support. Healthcare associations, companies and researchers will be able to join the community, disseminate their instructions, products and findings respectively and undertake crucial tasks such as the quality control of services and information. The use of community services will load the community database with valuable information concerning user feedback, patient needs, treatment suggestions, patient profiles and medical record history. The stockpiled information can be analyzed: by the community administrators who want to improve services, by scientists who perform medical research, by future patients who seek for a quick advice from a fellow-sufferer. The knowledge produced inside the community will be continuously filtered and managed in order to maintain quality.

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