

# Web Science in Medicine and Healthcare

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Web science, Social media, Medicine 2.0, Health 2.0, Information extraction

## Summary

**Objectives:** Medical social-media provide a new source of information within information gaining contexts. Facts, experiences, opinions or information on behaviour can be found in the medical web and could support a broad range of applications. The intention of this Focus Theme is to bring the existing research together and to show the possibilities, challenges and technologies for Web Science in medicine and healthcare.

**Methods:** This editorial provides an overview on the landscape of medical social-media and their possibilities in supporting healthcare. Further, it summarizes the three papers included in this Focus Theme.

**Results and Conclusions:** The three papers of this Focus Theme consider different aspects of Web Science in medicine which are 1) detection of drug interactions from social media, 2) inferring community structures from online forums and 3) improving access to online videos through assignment of SNOMED CT terms. All three papers show the potential of medical social-media in supporting health information gathering processes from the web. However, several issues still need to be addressed in future: Methods are necessary for identifying high quality information from the medical web as well as for processing the language that is used by social media users to report about their symptoms, diseases and other health issues.

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## 1. Introduction

In the western world, the age of the patient population requiring the most medical support for longer durations is increasing. The current healthcare model for supporting this greater need is not sustainable in the long term. Given that the web has emerged and is now a part of daily life, it may be one route to find solutions that improve this situation.

Advances in Internet and mobile technologies have improved the way people access, use and share information in the last few years. Hospitals, physicians or other healthcare providers are presenting their services as well as health information online on their websites with varying quality and readability [1, 2]. Beyond, new ways of communicating about health have evolved, enabling a 24/7 and location-independent medical-information exchange. These new media comprise instant messaging (e.g.

Twitter), blogs, online forums, social networking (e.g. Facebook) or video sharing (e.g. YouTube). This development leads to the question of whether health provision and education can benefit from using the web, and furthermore can create an environment in which individuals and communities become more able and responsible for their own health and treatment. Mayo Clinic researchers have opined that social media have begun a process of “revolutionizing healthcare” by improving healthcare and quality of life [3]. In analyzing the popularity of social media one cannot help but realize that one distinct advantage offered by this media is that the communication barriers are considerably lower than for face-to-face communication [4]. This may allow patients to write on social-media platforms more freely about their illnesses and their experiences with drugs and medical treatments than they would normally do in other settings. Personal experiences and opinions on health issues are shared with others who have the same health concerns already comprehensively through platforms like e-Patient Dave<sup>a</sup> or PatientsLikeMe<sup>b</sup>.

One of the most active groups of online health-information seekers are those who suffer from chronic conditions or from rare diseases [5]. By surfing for medical information in cyberspace this group of users can learn what others have to say about quality of care, or about important issues regarding treatment and diagnosis. In addition to gaining knowledge, this group of online medical-information seekers is able to communicate with other persons who are suffering from the same disease, thus reducing feelings of isolation and loneliness. All in all, social-media platforms offer a range of possibilities to facilitate the sharing of useful medical information and personal experiences related to healthcare, particularly when the information seeker is unable or feels being unable to obtain adequate support and feedback from fellow sufferers in the home community.

One cannot ignore the fact that social media have already dramatically changed

the structure of healthcare delivery in the modern world. From a medical data standpoint, important medical information is no longer exclusively found in patient clinical narratives, usually shared by physicians and other healthcare workers at regular professional meetings and conferences. Instead, user-generated content on the web has become a new source of useful information to be added to the conventional methods of collecting clinical data. Physicians can learn about the experiences of their colleagues provided through social media platforms such as weblogs, or forums. Beyond, they have access to latest results from clinical research. Health organizations also monitor online news repositories and web pages for relevant data on epidemiological events.

Another question is the usage of medical web data – it now provides a new source of information within information gaining contexts. Facts, experiences, opinions or information on behaviour could support a broad range of applications. With an increased interest internationally in E-Health, Health 2.0, Medicine 2.0 and the recent birth of the discipline of Web Science, this Focus Theme collects research in this field to investigate the application of Web Science to health education and healthcare. Medical social-media have created a burgeoning new class of empowered patients “armed with sophisticated technological tools” [6]. We can't afford to lose this source of medical data generated daily by healthcare consumers and providers who avail themselves of social-media platforms for sharing their clinical experiences.

## 2. The Landscape of Medical Social-Media

Medical social-media comprises weblogs, forums or social network platforms that deal with health-related issues. Forums are basically Internet message boards, where patients or friends and relatives of patients discuss their own experiences and personal thoughts or in the alternative ask questions and seek advice. A blog differs from a discussion forum in that all of the web site entries are displayed in reverse chronological order; a blog often has only one author

whereas many persons contribute to a forum. A blog is defined specifically as a medical blog, when its main topic is related to health or medicine [7]. The exact number of forums, blogs and blog postings dealing with health issues is unknown. For blogs in general, Weblog hosting services have made some numbers available. WordPress<sup>c</sup>, one of the popular Weblog hosting services, reports on its website that WordPress.com users produce about **29.2 million new posts and 40.5 million new comments each month**.

Health information is exchanged to an increasing extent in the web through these channels. To bring together health bloggers, entire communities have been set up. *Blognation* and *HealthBlogger Network* are examples of such communities. *Blognation*<sup>d</sup> is a network of blog directories that lists blogs for different categories including health, but also dealing with other topics, such as books, art, music, and lifestyle. The *HealthBlogger Network*<sup>e</sup> engages over 3,500 bloggers which can be broken down into two categories: healthcare professionals and patients. In general, about 50–60% of the healthcare bloggers are healthcare practitioners and medical researchers, often from the leading American medical schools such as Harvard or Yale, while the remaining 40–50% of bloggers is comprised of patients suffering from chronic or acute illnesses [8].

Besides blogger networks, patients or healthcare professionals are forming communities where they share their knowledge, discuss, or learn from each other. A well-known example of a medical social-media communication platform is *PatientsLikeMe*<sup>f</sup>. This is a social network for patients that allows them to share health-related experiences and to compare various treatment plans. Such online conversations which can also be in the form of a medical diary, often contain vast amounts of experiential knowledge. Other platforms, in contrast, try to make this kind of patients' first-hand experiences useable in some fashion. For example, patients' experiences

<sup>c</sup> <http://en.wordpress.com/stats/>

<sup>d</sup> <http://medical-blogs.org>

<sup>e</sup> <http://www.wellsphere.com/health-blogger>

<sup>f</sup> <http://www.patientslikeme.com>

<sup>a</sup> <http://epatientdave.com>

<sup>b</sup> <http://patientslikeme.com>

and opinions extracted from social-media postings can be exploited for planning marketing strategies in the pharmaceutical industry or in the healthcare insurance industry. As a result, healthcare products may be improved based on patients' reported personal experiences found in medical social-media. This approach challenges the more traditional evidence based medicine approach and it is interesting to see the debate around these approaches developed within the medical profession.

Medical social-media also represent a rich resource for learning about patient-compliance behavior, as well as their feelings, attitudes, and experiences with medical and surgical treatment. *Treato.com*, for example, is a social health site that analyses online patient discussions, collects automatically information about what patients have to say about their medications and conditions found on the blogs and other social-media fora, and subsequently extracts and summarizes the relevant information from these postings. This is done in order to provide valuable insights into patients' opinions, attitudes, and experiences that would help pharmaceutical companies better improve their products.

Platforms such as *Webicina*<sup>§</sup> provide access to curated, medical social-media which are defined as media that are filtered, selected and reviewed. This helps to make more efficient use of the massive amount of social-media data that is out there. Many of those who rely on *Webicina* are physicians, pharmaceutical companies and other healthcare professionals. *Webicina* is certainly not in a category all by itself as there are other enterprises that likewise try to make use of medical social-media data by effectively curating the information found in cyberspace [9, 10]. Beyond getting information on health-related issues, sudden changes in the public health status can be identified in medical social-media data. This allows for a prompt reaction, early on, from health organizations to such critical events like a swine flu outbreak [11].

### 3. Web Science in Medicine and Healthcare

As the brief description of the landscape of medical social-media has shown, a wealth of user-generated content is out there and automatic methods are essential for extracting relevant information, for organizing and digesting the data for various user groups as well as for preparing it for statistical analysis – or in simple terms: to make it ready for its use in healthcare, healthcare education and medicine.

Web Science is a new interdisciplinary field targeting at understanding what the web is, engineering its future and ensuring its social benefit [12]. Because the web has grown to play a significant role in the lives of many, it has the potential to provide a means to solutions that address aspects of these health care problems. Facts, experiences, opinions or information on behaviour can be found in medical social-media and could support a broad range of applications as it has been shown in the previous section.

The research community is becoming increasingly aware of new possibilities and research challenges of the medical web. For example, the diversity provided by this huge information source which is the medical web is one of the crucial aspects to be considered [13]. Language peculiarities, content diversity, streaming nature of this specific data poses many challenges given the increasing content on the web and the trade-off of filtering noise at the cost of losing information which is potentially relevant. Indeed, the processes of information gathering makes demands that also need to be considered by researchers as well. The intention of this Focus Theme is to bring the existing research together and to show the possibilities, challenges and technologies for Web Science in medicine and health.

### 4. Description of Papers

The issue includes three contributions from researchers working on Web Science in medicine and healthcare. In particular, the research focuses on two important online health resources which are 1) online

discussions and healthcare forums as well as 2) YouTube videos. The authors of the papers introduce methods on how to make use of the data from these online sources for healthcare purposes.

#### 4.1 Exploiting Online Discussions to Discover Unrecognized Drug Side Effects

One important type of content provided in the web are experiences from patients that are undergoing some medical treatment, rely upon drugs and medical procedures. Drugs are supposed to treat human diseases. However, the ingredients can unexpectedly interact with off-targets and cause in this way adverse drug effects. In their paper, Wu and Fang [14] follow the assumption that in online discussion forums patients share their personal knowledge about side effects; thus, the web provides a huge source of experiential knowledge which could help to learn earlier about drug side effects. The main goal of their paper is to investigate whether online discussions can be exploited to learn more about drug side effects.

#### 4.2 Inferring Community Structure in Healthcare Forums: an Empirical Study

The paper of Chomutare et al. [15] examines the social structures in online communities. While existing work concentrated on analyzing community structures in social networks such as *PatientsLikeMe*, this particular paper included in this focus theme examines interactions in healthcare forums. In more detail, the authors perform a study to find out whether these interactions in healthcare forums can be represented as networks. In contrast to interactions in social networks, in forums (message boards) no explicit relationships are given, but relationships in forums are encoded in large datasets of forum threads-and-comments dynamics. The authors apply methods from network analysis to decipher these relationships and apply a quality function based on user interaction similarity to assess the quality of the discovered communities. Their results show

<sup>§</sup> <http://www.webicina.com>

that meaningful communities can be identified by observing forum interactions.

### 4.3 The role of Taxonomies in Social Media and the Semantic Web for Health Education: A study of SNOMED CT Terms in YouTube Health Video Tags

Another huge resource of health information are videos made available in YouTube by patients, health organizations or health professionals. The videos allow to get information on surgical procedures, on diseases or vaccination or other medical treatment procedures. The paper by Konstantinidis et al. [16] describes a framework that allows to collect YouTube videos dealing with health issues and to map tags assigned to the videos to concepts of the SNOMED CT ontology. The objective of the authors is to study to what extent the YouTube tags can be mapped to SNOMED CT concepts. This mapping is a crucial step to allow for searching of YouTube resources in content or learning management systems, in particular for knowledge expansion in such systems. Beyond, the authors demonstrate how information resources like YouTube videos can be exploited within content or learning management systems.

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