



# Modeling the dynamics of medical information through web forums in medical industry



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## ABSTRACT

In this study, we propose the web forum analysis model that can support corporate foresight activities. The medical industry can utilize the rich, objective decision-making data contained within web forums through which participants who have common interests disseminate and receive information and form self-contained communities. We collect and analyze the contents of the web forum using Web, text, and data mining techniques. We identify the major needs of Alzheimer disease patients and their families. We also show how to track the time-series patterns of major topics providing insight to the medical industry. Furthermore, we study the dynamic mechanisms of major needs using the epidemic model and describe how users in a web forum collectively participate in topic discussions. Using the proposed model, the medical industry can predict the future market by estimating how long a topic will persist and how strongly a topic attracts attention.

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## 1. Introduction

Internet access is a widely diffused technology in the U.S.; about 81% of American adults (18+) are online [1]. High-speed broadband connections [2] have accelerated this increase in the number of Internet users. The first type of Internet, Web 1.0 followed a top-down approach to the use of the web and its user interface [3–5]. Only servers were able to control and provide information to Internet users. Advances in information technology infrastructure have created many Internet users, and they have started to participate in creating content. The rapid increase of Internet users has facilitated the development of the more socially oriented Web 2.0 technologies, which

include various applications and social networking media, such as web forums, blogs, wikis, and media-sharing websites [3–6].

Nolte et al. [7] and Singh et al. [8] reported that this new information and communications technology (ICT) being developed would be helpful for new models of integrated health and long-term care. Elkin [9] reported that 59% of adults use online resources to obtain health and wellness information, and 34% of health searchers use social media resources to find health-related topics through Web 2.0 sites that feature other areas of interest and hold a particular appeal for individuals researching information about health and wellbeing. The characteristics of Web 2.0 in the medical industry are follows:

### 1.1. User group

Web 2.0 users in the medical industry are divided into two groups: a demand-side group (e.g., patients and their social circle, including ex-patients and patients' families) and a supply-side group (e.g., medical technology companies,

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health care institutions, pharmaceutical companies, public and private funders, and clinicians) [10].

### 1.2. Advantages

The Internet is an easy-to-use, quick, and inexpensive tool for obtaining information [11,12]. Patients and their relatives can benefit from these advantages by using web forums to research people's opinions [13,14] and obtain socially supportive communication, information support (e.g., sharing their experiences and exchanging information on remedies, therapies, medical technologies, health, and health care), and emotional support (e.g., caring, concern, sympathy, and empathy) [15–17]. Griffiths et al. [10] suggested that social networking via Web 2.0 technology has the potential to determine patients' needs by identifying changing patterns in health care; the posts written by patients expressing their medical opinions are, in their own right, effective channels between supply and demand actors. They also focus on useful health-information social sites for improving the use of care information as a foresight tool. A more intense usage of Web 2.0 might help all medical professionals to obtain up-to-date information [18,19]. People who are interested in health and wellness (or who are researching their symptoms and treatments) can connect, communicate, and share health information with informed patients, their families, and doctors. They seek medical information for improving or maintaining their health from a variety of people who use the web [20,21]. Sharing health-related information through web forums provides people with information support (e.g., disease progressions, patterns of illness, and responses to treatments) as well as emotional support (e.g., consolation or courage from learning of other patients who have overcome). This support has given rise to the rapid growth of medical web blogs that could enable patients and their social circles to communicate among themselves and with service providers [20].

### 1.3. Disadvantages

Internet users tend to use nicknames or remain anonymous; thus, it is difficult to ascertain the identities of the individuals who post on web forums. It is very difficult to identify bloggers' demographic information and thus compare demographic samples [11,22]. In addition, there is the issue of biased sampling. The Internet does not represent all social classes for the following reasons: (1) people who are not able to use the Internet cannot participate in web forums and (2) some people dislike using the Internet [11,23]. There are also concerns about the accuracy and quality of information because of users' anonymity. However, Adams emphasized that medical blogs are considered to have an advantage, because they enable the integration and combination of much more information on the web, which could improve its reliability [24]. As more patients use blogs, the knowledge is connected and cross-checked much more. This could improve the reliability of blogs. Patients and their family members use medical web blogs because they can provide health information and support their interactions with physicians in various important ways, regardless of concerns about the reliability of information obtained online [16,24].

As medical websites are increasingly utilized, scholarly interest in web mining, data mining, topic detection, and the

use of diffusion models on these sites has increased [25–27]. Much previous research on medical information blogs has been conducted [28–31] because blogs constitute a real-world social network [27]. The research on web forums differs from that on blogs in that it focuses on the diffusion vector that includes topics, news, and documents. Kubo et al. [25] showed the analogy between the disease propagation model, the SIR model, and posting data in web forums. Woo et al. [27] applied the SIR model to political web forums.

In this paper, we suggest the foresight support system for the medical industry through a more appropriate diffusion model for medical web forums. We extracted “hot topics” through data mining of medical web forums on Alzheimer's disease (AD) to track trends in emotional and informational support, to analyze how hot topics proliferate through the information diffusion model, and to foresee the medical industry. Our methodology of modifying and applying an information diffusion model to medical web forums might offer several hints to the medical industry by showing the propagation speed, power, and lifetime of hot medical topics.

Our main contribution is that we built a more appropriate diffusion model for medical web forums by combining hot topic analysis with time-series analysis. We aimed to understand the spread of hot topics in order to predict their success or failure in the early stages, and to shape the underlying process to increase or reduce the chances of diffusion. The analysis of the model results can be used by supply-side groups in medical industries such as medical technology companies, health care institutions, pharmaceutical companies, clinicians, and policy-makers for preparing their respective future strategies.

This paper is organized as follows. Section 2 reviews relevant literature, Section 3 introduces the methodology, Section 4 includes the results of the data analysis, and Section 5 is the conclusion.

## 2. Literature review

The domain literature related to this paper can be divided into 2 parts: social support from medical web forums and information diffusion, and foresight support systems. These are discussed in the following subsections.

### 2.1. Social support through medical web forums

Bloom [17] summarized the relationship between social support and health. Taylor [31], Schaefer et al. [32], Cobb [33], and House et al. [34] have defined four categories of social support: emotional support (warmth and nurturance expressing commitment; reassuring the person that he or she is a valuable individual who is cared for, including approval or appreciation for the patient's behavior), appraisal support (helping a person to better understand a stressful event and identify resources and coping strategies that may be mastered to manage it), informational support (providing advice and information), and tangible assistance or practical-instrumental support (material or other practical help such as services, financial assistance, or goods).

The proliferation of health-related information on the Internet has prompted recent content-analysis studies of

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