



Improving knowledge of patient skills thanks to automatic analysis of online discussions

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ABSTRACT

Objective: Automatically analyze the online discussions related to diabetes and extract information on patient skills for managing this disease.

Methods: Two collections of about 7000 and 23,000 messages from online discussion fora and 174 skills from an available taxonomy are processed with Natural Language Processing methods and semantically enriched. Skills are projected on the messages to detect those skills which are mentioned by patients. Quantitative and qualitative evaluation is performed.

Results: The method recognizes almost all the aimed skills in fora. The quality of the skills' recognition varies with the method's parameters. Most of the selected messages are relevant to at least one of the associated skills. Manual analysis shows a substantial number of messages is dedicated to daily self-care and psychosocial skills.

Conclusion: Study of real exchanges between patients leads to a better understanding of their skills in daily self-management of diabetes.

Practice implications: Our experiments can be useful for a better understanding and better knowledge of self-management of diseases by patients. They can also refine existing patient education programs.

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1. Introduction

For several years now, the Internet has been the main source used by patients to find medical knowledge [1,2]. Different kinds of medical documents are accessible on the Internet (web pages, online discussion fora, support groups websites, news articles, scientific papers, etc.) and these can help patients to understand and manage their diseases [3–6].

We assume online discussion fora (ODFs) are a precious source of information about exchanges between patients. It is crucial then to analyze them for identification of the skills patients put into practice and of patients' needs regarding self-management of their diseases.

1.1. Medical context

The French legislation establishes the therapeutic patient education (TPE) in the French healthcare system (Hospital, Patient,

Health and Territories law). Moreover, healthcare professionals must help patients to acquire and to maintain their skills for a better management of chronic diseases. Thus, designing educational contents and pedagogical methods requires a better understanding of the daily requirements and current skills of patients [7].

The diabetes mellitus (DM) is a chronic disease for which one of the recurrent problems is its understanding by patients. This is particularly true for the diabetes mellitus 1 (DM1), which appears at the early stages of life. TPE aims at helping patients with management of insulin dosage, glycemia, hyperglycemia and hypoglycemia in various contexts (sport, diet, work, etc.). Diabetes is the first priority in France: the first TPE content addressed diabetes, and currently 30% of the 2660 authorized TPE programs by the French Regional Health Agencies are related to diabetes [8,9].

1.2. Background and objectives

Research on TPE mainly focuses on documents creation adapted to patients. These are usually issued from texts dedicated to physicians [10]. Such an approach requires control of their accessibility [11], readability [12–14] and relevance [15]. Before being able to create such documents, physicians have to first

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correctly understand what the patients' real needs are. To avoid bias which may be caused by physicians, survey of patients' needs should rely on analysis of patients' discussions, such as those from ODFs.

Indeed, the Internet has become an essential means for patients in health management and support [16,17]. It is also noteworthy that a real public health area has appeared on the Internet [18]. There, patients can exchange information among themselves and help each other in supporting and facing complex situations and in understanding and managing their pathology. Development of ODFs, blogs and social networks leads to several benefits. First of all, it helps patient empowerment by enabling them to look up and share information about their disease [2,19,20]. Moreover, it motivates research on patient education and study of patient skills [21,22]. ODFs are becoming an important source for understanding other aspects: patient behavior [18,23], dialogue between doctors and patients [24,25], improvement of education programs [26], interaction among patients [27], rules underlying the organization of patient exchanges [28,29], differentiation among patients profiles and motivations [18,30] and information trustworthiness in ODFs [28,31–33]. Besides, patient vocabulary has been compared with the terms issued from the Unified Medical Language System (UMLS) [34] which is a terminology collection traditionally used in the medical domain. The experiment shows that they have only a small overlap and that an effort should be done to define a patient knowledge model in order to improve dialogue between physicians and patients [35]. In another work, exchanges between patients and physicians have been characterized with a taxonomy [36], which was helpful to identify patients' skills and to improve communication.

In an education context, ODFs are generally analyzed manually: to evaluate the model designed for improving patient communication skills [37], to assess the impact of patients' empowerment [38], and to analyze online discussions dedicated to pregnancy problems [39]. When performed automatically, such analysis is usually based on statistical or machine learning approaches [40,41] in contexts related to information retrieval: identifying fora which propose the most relevant information [42], identifying topics of patients discussions [43], etc.

In our work, we propose to automatically analyze ODFs dedicated to diabetes. We aim identify patients skills and mapping these skills to an existing taxonomy [44–46]. This taxonomy has been created manually and describes pedagogical content of training programs dedicated to diabetic patients. It relies on the constructivism [47] and pedagogy of integration [48] principles. Its content has been defined thanks to recommendations on skills the patients should have. For instance, self-care skills cover decisions related to management of treatments and their consequences; while adaptation skills describe life changes possibly induced by chronic diseases and their management [46,49,50]. A special place is given to metacognitive skills because they play a crucial role in self-confidence, self-evaluation during the learning process [51] and acquisition of other skills [52] (see Section 2.1.2). Previously, this taxonomy was used as a framework for skill inference from ODFs inductive analysis [53], during which some difficulties appeared [54]:

- When patients mention their skills in the ODFs, they do not always use the taxonomy terms;
- Some skills mentioned by patients are not described in the taxonomy;
- While some skills are very frequent, other skills are missing in ODFs.

In previous manual work, two thirds of the processed ODF messages were associated with this taxonomy [55]. The observations remain incomplete and inconclusive because only few messages were analyzed. Our current objective is to go beyond these studies and to perform a systematic survey of the messages posted on French ODFs. We propose to use Natural Language Processing (NLP) approaches to semantically code and analyze messages and patients' skills. We perform quantitative and qualitative analyses to obtain a better knowledge of patients' skills.

2. Methods

2.1. Material

2.1.1. Corpora of forum discussion

We chose the two most active French language ODFs on diabetes (messages posted before June 2011):

- *Les diabétiques* (<http://www.lesdiabetiques.com/modules.php?name=Forums>) forum contains 839 threads and 6982 messages (624,571 words);
- *Diabetes Doctissimo* (http://forum.doctissimo.fr/sante/diabete/liste_sujet-1.htm) forum contains 22,532 threads and 560,066 messages (35,059,868 words).

2.1.2. Skill taxonomy

174 patient skills have been grouped into nine categories (Fig. 1) and are hierarchically structured [46]. Most of the skills are verbal phrases which shortly describe the skill, as in Fig. 2 (each level specifies its upper level).

2.1.3. Linguistic resources

Because the vocabulary used in the skill taxonomy differs from patient vocabulary [35,54], we expand its coverage with linguistic “vague” resources providing synonymy and associative relations. We assume that a certain degree of vagueness in the expansion may be useful given different expertise levels of contributors:

- The French general dictionary *Le Robert* [56], which provides 149,309 synonyms for 48,859 words may contain fuzzy see-also relations;
- Three distributional resources:
 - *FreDist* (<http://fredist.gforge.inria.fr/>) [57] built from the newspaper *L'Est Républicain* and the French version of Wikipedia. It contains 24,749 words (nouns, adjectives, adverbs and verbs) and their 1,853,475 semantic neighbors;
 - *Les voisins de Le Monde (VdLM)* (<http://redac.univ-tlse2.fr/applications/vdLM.html>) [58] built from the newspaper *Le Monde*. It contains 145,164 words (nouns, adjectives, phrases and prepositions) with 2,762,739 semantic neighbors;

Skills 1: Express and explain the needs regarding the pathology

Skills 2: Understand and explain the pathology to oneself

Skills 3: Identify the symptoms, analyze a risk situation, interpret and measure values;

Skills 4: Manage emergency situations

Skills 5: Solve problems (therapy, material, complications)

Skills 6: Practice, know how (insulin injection, self-regulation, etc.)

Skills 7: Readjust diet and insulin treatment

Skills 8: Assert the rights at work, at school, and use the healthcare system

Skills 9: Meta-cognitive skills (anticipate and plan actions, self-evaluate)

Fig. 1. List of skill categories.

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