Do Medical Professionals Tag Images Differently from Non-Medical Professionals? An Implication of Retrieving User-Generated Images of Everyday Medical Situations

Ming-Hsin Phoebe Chiu¹, Wei-Chung Cheng², Kai-Ying Chu³, Chia-Chi Lin⁴, Shing Yeung⁵
Graduate Institute of Library and Information Studies, National Taiwan Normal University
No.162, Sec. 1, Hoping East Rd., Da-an District, Taipei, Taiwan, 10610
phoebechiu@ntnu.edu.tw¹, weichung1222@gmail.com², k400040551@gmail.com³,
smile10274@gmail.com⁴, m8741009@ems.ndhu.edu.tw⁵

ABSTRACT
Mobile photography not only allows people to take and share photos of everyday life, but also demonstrates the capability of emergency and crisis reporting at a critical moment. These images of everyday medical situations help the public understand the first-hand situation of those dramatic events, and facilitate the medical professionals to allocate medical resources and effectively diagnose. However, as the world is becoming more globalized and the communication between physician and patients is becoming more difficult as the healthcare practice becomes more complex, to be able to more effectively retrieval these user-generated images scattered throughout the Internet is of great importance. Social tagging is one such approach of managing and discovering photos for specific use. In response to the research gap and practical challenges, this study employs between-subject quasi-experiment method to investigate the tagging behavior of users of images of everyday medical situations. It aims to identify the differences of image tagging behaviors between two socially distinct groups, medical professionals and non-medical professionals. Results of the study may contribute to the increase of awareness and understanding of social media in healthcare, and the development of tag-based medical image retrieval service that is socio-cultural sensitive.

Keywords
Social tagging, image tagging, everyday medical situations, user-generated medical images

BACKGROUND AND RELATED STUDIES
Medical image in the traditional sense is the illustrative representation of internal structure or function of an anatomic region in the form of an array of picture elements (Larobina & Murino, 2014). Commonly used medical imaging techniques are, for example, Computed Tomogram Scan (CT Scan), Magnetic Resonance Imaging (MRI), Ultrasound, and Xrays. Most of these images are for diagnostic or educational purposes because they allow doctors to examine inside the body for clues about medical conditions. With the advance mobile photography and social media, pervasive photo-taking and photo-sharing is emerging through the use of mobile devices, and is changing the way we preserve moments in our daily life. These user-contributed images of everyday medical situations may be taken in the emergency room, an earthquake-hit area, in the kitchen with broken dishes and bowls. As opposed to the lab-based machine-generated medical images, medical images contributed by everyday users show great value in stimulating insights into the context of making sense of a medical or emergent situation, responding to and recovering emergency, and sustaining and preserving lessons learned.

According to a recent survey study conducted by American Red Cross (2012), social media and mobile apps would motivate people to prepare in emergency situation. Despite the increasing use of social media in emergencies, many focus on the potential of implementing and integrating social media to cope with disaster and emergency preparedness. Sanghooe (2015) highlights Facebook’s new disaster-specific feature Safety Check, and its ability to help people track their friends and family during the suffering period of Nepal’s tragic earthquake in 2015. Merchant, Elmer, and Lurie (2011) argue that people use social media not only in daily communication, but also during disasters that threaten public health. Yasin (2010) identifies five ways to use these user-contributed content on social media for better emergency and disaster response, and of critical importance is to monitor the conversation (including texts and photos), integrate all data sources to be gathered for
Creating situational awareness, and collaborate with the responders (such as hospitals and civilian agencies) for resource allocation. However, as the world is becoming more globalized and the communication between physician and patients is becoming more difficult as the healthcare practice becomes more complex, to be able to more effectively retrieval these user-generated images scattered throughout the Internet is of great importance.

Social tagging is one such approach of managing and discovering photos for specific use. Social tags, as a representation of semantic interpretations and annotation, have brought proven benefits on searching tasks from the enormous collections of digital media (Morgan & Naaman, 2007). Social tagging and folksonomy are seen as solution in preventing the problems associating with fixed pre-defined metadata, that may be too broad or too specific to the massive collections of user-generated digital objects (Gupta, Li, Yin, & Han, 2010). Social tags are user-generated descriptive terms that people associate with the information object being tagged. There is a widespread perception among people that social tags facilitate organization of information and eventually improve understandability, findability and discovery of information (Hammond, Hannay, Lund & Scott, 2005; Golder & Huberman, 2006; Guy & Tonkin, 2006; Macgregor & McCulloch, 2006).

Recent research effort to investigating the use of social tags in the medical context can be found in three directions of applications described as follows. First direction of study focuses on the automatic content-based medical image retrieval approach with the use of tags for clinical purposes, for example, Muller, Michoux, Bandon, & Geissbuhler (2004) and Kim (2013). Second direction deals with the practice of medical professionals assigning and using social tags to organize and retrieve academic literature and medical information resources. These study find that user-generated terms are often not of formal thesaurus (Kipp, 2007), and the author keywords show advantages over collaborative tags in retrieval effectiveness of medical collections (Lu & Kipp, 2014). Third direction focuses on the application of social tagging on recent pervasive development of social media content. Denecke and Nejdl (2009) analyzes how physicians and patients make sense of medical social media, such as medical blogs and medical Q&A portals, through extracting concepts of semantic types of the social media resources. Results of the study find that medical social media resources can be divided into affective and informative resources. Linehan et. al (2010) conduct a study of how users of photographic food diaries to photograph their own meals and tag the photos. The study finds that by analyzing the tags created by the photo takers, promising method of designing healthier-eating interventions and highlighting and extracting useful nutrition information may be proposed. Garimella, Alfayad, and Weber (2015) collect and analyze the tags/hash tags created for food-related photos and identify what is being perceived as healthy and unhealthy food consumption. Similar implication is being done by inferring caloric value of food from the food-specific annotation of food images (Sudo, Marusaki, Shimamura, & Taniguchi, 2014). Up till now, studies have presented mixed results of the effectiveness of social tags and controlled vocabularies, but they do recognize the potential value of analyzing the behavior of social tagging and the content of the tags themselves.

The social role difference between physicians and patients in health communication is primarily grounded in the inherent difference of between expert and novice in terms of two parties’ medical–related domain knowledge. Further, the differences between expert and novice can be even more explicit when applying this concept to reasoning the problem and taking on information searching task. When comparing search behavior with the social tagging systems, Kang and Fu (2010) find that experts rely more on their domain knowledge to generate search queries, while novice are influenced more by social cues in the social tagging system. Wang et al (2012) explore how novices, intermediates, and experts would describe radiological medical images, and find that experts employed more high-level image attributes which require high reasoning or diagnostic knowledge to search for a medical image, and novices are more like to describe some basic objects which do not require much domain knowledge to search for an information they need.

In response to the research gap and practical challenges, this study attempts to answer the research question: How do the characteristics of observed tagging behavior of images of everyday medical situations differ for medical professionals and non-medical professionals? This study is designed as a between-subject quasi-experiment method to investigate the tagging behavior of users of images of everyday medical situations and identify the differences between two socially distinct groups, medical professionals and non-medical professionals.

STUDY DESIGN AND METHODS

Research Participants

For the purpose of this study, a between-subject quasi-experiment design was employed. The sampling criteria for recruiting participants and the experiment procedures are inspired by Dong and Fu (2010). As an exploratory study, 5 medical professionals and 5 non-medical professional participants were recruited into the study from personal social network and social media advertisement. The sampling criteria for the two groups are as follow:

- Medical professional participants: (1) Adult, of age 18 or older; (2) Currently practicing medical professionals with active license, or medical or student with at least four years of studies pursuing medical-related degrees or national qualifications in medical schools.
Non-medical professional participants: (1) Adult, of age 18 or older; (2) Does not have formal education in the medical or related fields; (3) At least hold a college degree, certificate, or relevant postsecondary credentials.

It is worth noted that while medical professionals’ specialization (such as dermatology and gynecology) would potentially affect how they conceptualize a medical situation and eventually the tagging behavior and tags created, but in this exploratory study, the physicians’ specialization is not taken into consideration.

Data Collection
All participants were presented the same materials and experienced the same procedures. A total of 30 images were selected from the search results using commercial search engines, social media sites such, and medical-based mobile applications such as Figure 1 (https://figure1.com/). Criteria to select images were partly inspired by Dong and Fu (2010): (1) photo of real-life objects or situations; (2) in the born-digital form, (3) must be user-contributed; (4) should be related to medical situations in everyday life; (5) must contain at least one clear foreground main object and a number of distinguishable background objects; (6) the main object must belong to one of the three categories: human, medical facility or situations, and human body parts. Three groups of images, 10 each with main objects being human, medical facility or situations, and human body parts, were selected. A sample image in each category is provided in Table 1. An online questionnaire containing all thirty images were created, and tags are added to an image right after it is viewed till all 30 images are tagged with free-text user-generated keywords.

Data Analysis
This study employed a mixed-method data analysis strategy for the tags created by the participants, including both qualitative and quantitative inquiries. Qualitative analysis of tags include average number of tags assigned, average length of tags assigned by word count. In analyzing the semantics of tags, two steps were taken. First step utilized a qualitative constant comparison method to extract the common attributes of the tags. The attributes then were grouped as categories or concepts, which refer to the medical concepts represented by the created tags. The results were compared between two groups to investigate the difference between two socially created roles, as well between three groups of image types.

PRELIMINARY FINDINGS
Average Number of Tags Assigned
According to the results shown in Table 2, a total of 731 tags for 30 images were created by 10 research participants, in which 462 (63%) tags were assigned by participants without medical background and the rest 269 (37%) tags were assigned by participants with medical background. On average, participants with medical background assigned 1.79 tags per image while participants without medical background assigned 3.08 tags. It is found that individuals with medical background would use less but more precise tags, often case the official medical terms, to describe the images. For example, in an image of a car accident, a participant without medical background used three distinct terms “skin” and “burns” “fire” while a participant with medical background used “skin burns” to describe the same concept.

<table>
<thead>
<tr>
<th>Types of Participants</th>
<th>Non-Medical Professionals</th>
<th>Medical Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tags assigned per image</td>
<td>15.4</td>
<td>8.97</td>
</tr>
<tr>
<td>Average number of tags assigned by each participant</td>
<td>3.08</td>
<td>1.79</td>
</tr>
</tbody>
</table>

Table 2. Average Number of Tags Assigned

Average Length of Tags Assigned by Word Count
The average length of tags assigned per image by using word count tool is 2.665. More specifically, participants with medical background used an average of 2.55 words per tag, while participants without medical background used 2.78 words per tag. Similarly, the findings show that participants without medical background tend to use tags with longer length to describe the images.

Across image types, the study finds that the perceived complexity and relatedness do influence how the images are
tagged. Complexity in this study is defined as the degree of information exists in the image, and relatedness is defined based on respect to the individual’s own social and personal distance to the image content/concept described. For example, an image of both foreground and background objects may carry more information than an image of only a focal single object, and an individual may find more related to an image of human as main object than a single body part or a medical equipment as main objects. As shown in Table 3, tags for images of human as main objects have an average of 2.86 words per tag, while tags for images of medical facility or situations and human body parts have an average of 2.68 and 2.47 words per tag.

<table>
<thead>
<tr>
<th>Types of Image</th>
<th>Non-medical Professionals (words)</th>
<th>Medical Professionals (words)</th>
<th>Average (words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image of human as main object</td>
<td>3.04</td>
<td>2.68</td>
<td>2.86</td>
</tr>
<tr>
<td>Image of medical facility or situations as main object</td>
<td>2.77</td>
<td>2.59</td>
<td>2.68</td>
</tr>
<tr>
<td>Image of human body parts as main objects</td>
<td>2.55</td>
<td>2.38</td>
<td>2.47</td>
</tr>
</tbody>
</table>

Table 3. Length of Tags by Image Types

Semantics of Tags
To further analyze the characteristics of all 557 distinct tags created by 10 participants, this study was able to categorize the tags into seven attributes according to the relations between tags and medical-related concepts. According to Table 4, most of the tags focus on observable facts, while only 7.7% of the tags describe subjective personal feelings that result from viewing the images. The study finds that almost 1/3 (66.2%) of the tags provide description on the possible cause and the underlying conditions. Among them, tags from non-medical professionals tend to speculate on the observable signs and conditions, while medical professionals would directly apply specific disease or conditions with medical terminologies. Tags on medical related objects primarily focus on the medical equipment or facilities. It may show intellectual value on the medical preparedness for emergency response.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Non-Medical Professionals</th>
<th>Medical Professionals</th>
<th>Average</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observable Signs and medical conditions</td>
<td>232 (41.7%)</td>
<td>164 (29.3%)</td>
<td>369 (66.2%)</td>
<td>Burns; Blood; Herpes;</td>
</tr>
<tr>
<td>Personal feelings</td>
<td>26 (4.7%)</td>
<td>17 (3.1%)</td>
<td>43 (7.7%)</td>
<td>Great loss; Horrible</td>
</tr>
<tr>
<td>Non-human Object (Medical Related)</td>
<td>26 (4.7%)</td>
<td>21 (3.8%)</td>
<td>47 (8.4%)</td>
<td>Scalpel; Glasses</td>
</tr>
<tr>
<td>Human organs or body part</td>
<td>18 (3.2%)</td>
<td>11 (2.0%)</td>
<td>29 (5.2%)</td>
<td>Fingers; Heart</td>
</tr>
<tr>
<td>People</td>
<td>14 (2.5%)</td>
<td>7 (1.3%)</td>
<td>21 (3.7%)</td>
<td>Infant; Doctors</td>
</tr>
<tr>
<td>Location</td>
<td>13 (2.3%)</td>
<td>4 (0.7%)</td>
<td>17 (3.0%)</td>
<td>Boston; Highway</td>
</tr>
<tr>
<td>Object (Non-Medical related)</td>
<td>4 (0.7%)</td>
<td>1 (0.2%)</td>
<td>5 (0.9%)</td>
<td>Necklace; Insects</td>
</tr>
<tr>
<td>Total/Average</td>
<td>333 (59.8%)</td>
<td>224 (40.2%)</td>
<td>557 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Attributes of the Tags by Two Groups of Participants

CONCLUSIONS
The results of this study may provide insights into the cultural and social factors may affect the conceptualization and communication of at times of emergent and actual crisis. Results of average number and length of tags assigned may indicate the difference in communication patterns by individuals with and without medical background. It implies that individuals without medical background may take longer time and extra effort to understand and explain an emergent medical situation involved. The semantic attributes of the tags derived from the analysis may facilitate those who search the images with specific purpose, for example, images of a human body part or a particular type of surgical procedure, or an emergency type such as earthquake or car accident.
With much attention and effort being put in the development of digital health and its introduction into more areas of medical practice, medical professionals and police services are beginning to recognize the potentials of social media in crisis reporting and means of allowing a wider audience and stakeholders to become more aware of the dramatic situation at the crisis emergent scenes. In recent crisis such as Orlando Shooting, Terrorism in Paris, Boston Marathon Bombing, user-generated images made available right at the scenes have helped us witness and understand the first-hand experience of those dramatic events. Designing for emergency preparedness with the advantage of social media has become a priority social media developers, medical practitioners, and agencies from public sector. These images have value because they provide essential information not only for identifying the cause of medical conditions for medical purpose, but also for crisis investigation and even educational purpose. As the world is becoming more globalized and the communication between physician and patients is becoming more difficult as the healthcare practice becomes more complex, to be able to more effectively retrieval these user-generated images scattered throughout the Internet is of great importance. The results of this study may provide insights into the cultural and social factors that affect the conceptualization and communication of at times of emergent and actual crisis.

REFERENCES