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Detection of consensuses and treatment principles of diabetic nephropathy in traditional Chinese medicine: A new approach

Xu Tong [a], Qingyu Xie [b], Guang Rong [a], Sheng Zhou [a], Qinggang Meng [a,*]

[a] School of Basic Medical Science, Beijing University of Chinese Medicine, Beijing 100029, China
[b] Institute of Basic Research in Clinical Medicine, China Academy of Chinese Medical Sciences, Beijing 100700, China

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Abstract *Objective:* To propose and test a new approach based on community detection in the field of social computing for uncovering consensuses and treatment principles in traditional Chinese medicine (TCM).
Methods: Three Chinese databases (CNKI, VIP, and Wan Fang Data) were searched for published articles on TCM treatment of diabetic nephropathy (DN) from their inception until September 31, 2014. Zheng classification and herb data were extracted from included articles and used to construct a Zheng classification and treatment of diabetic nephropathy (DNZCT) network with nodes denoting Zhengs and herbs and edges denoting corresponding treating relationships among them. Community detection was applied to the DNZCT and detected community structures were analyzed.
Results: A network of 201 nodes and 743 edges were constructed and six communities were detected. Nodes clustered in the same community captured the same semantic topic; different communities had unique characteristics, and indicated different treatment principles. Large communities usually represented similar points of view or consensuses on common Zheng diagnoses and herb prescriptions; small communities might help to indicate unusual Zhengs and herbs.
Conclusion: The results suggest that the community detection-based approach is useful and feasible for uncovering consensuses and treatment principles of DN treatment in TCM, and could be used to address other similar problems in TCM.

* Corresponding author.
E-mail address: mqgang@126.com (Q. Meng).
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Introduction

In complex network theory, a social network is a social structure made of nodes (individuals or organizations) connected by edges to exemplify various relationships such as friendship, affiliation, or cooperation. Community detection is one of the fundamental tasks in social network analysis. It solves problems by studying groups rather than individuals. Finding a community in a social network is a function of identifying a group of nodes that interact with each other more frequently than with nodes outside the group.[1] The real-world significance of identifying such communities are, for example, that friends in the same group share more similar interests and interact with each other more frequently[2]; that community analysis has uncovered thematic clusters on the Internet[3]; and, in biochemical or neural networks, that communities may be functional modules.[4] Nowadays, social computing research has gradually shifted from its traditional research fields such as computer science and engineering to other fields such as health services and communications.[5] He[6] et al and Chang[7] et al extended social cooperation networks to the field of traditional Chinese medicine (TCM) based on a theory that different herbs work together in a complementary manner to treat a disease. Their research also presented a traditional Chinese herbal prescription formulation network (TCHPFN).

In China, TCM herbal formulas have been widely used to treat many diseases. Zheng classification and treatment (ZCT, *bian zheng lun zhi,* in Chinese) is a unique feature of TCM, and use of TCM herbal formulas must follow ZCT. Many studies have been conducted to illustrate that treatment based on Zheng classification can improve specificity and efficiency in both TCM and Western medicine.[8–10] However, Zheng classification depends mostly on the observations, knowledge, and clinical experience of TCM practitioners.[11] Zheng diagnosis always varies from practitioners, leading to different formulas, although with equivalent efficacy. There might be underlying consensuses and treatment principles among TCM practitioners to guide their treatments. Therefore, we proposed a community detection-based approach to uncover the underlying consensuses and treatment principles, and tested the approach by applying it to the Zheng classification and treatment of diabetic nephropathy (DNZCT) data. We present the DNZCT network as a social cooperation network of different Zhengs and herbs, and analyze the potential communities in the DNZCT.

Materials and methods

Search strategy

Databases searched include the China National Knowledge Infrastructure Database (CNKI), the Chongqing VIP Chinese Science and Technology Periodical Database (VIP), and Wan Fang Data from their inception to September 31, 2014. The following search terms were used individually or combined: "DN", "diabetic nephropathy", "*xiao ke* (in Chinese)", "*xiao ke shen bing* (in Chinese)", "traditional Chinese medicine", "Chinese herbal medicine", "herb", "Zheng", "*bian zheng lun zhi*in Chinese".

Inclusion criteria

We included those articles that focused on the Zheng classification and treatment of DN and that contained specific information on ZCT and herbs.

Exclusion criteria

We excluded: (1) reviews without Zheng and herb information; (2) articles on animal or cell experiments; (3) meta-analyses and articles on safety and effect evaluation; (4) studies on data mining or bibliometrics; (5) news; and (6) studies with unclear data.

Article selection proceeded as shown in Fig. 1.

Data extraction

Data were extracted using a predesigned data extraction table. The extracted data included Zheng classification, herbs, and ZCT details.

Quality control

Two authors conducted the literature search (TX, XQY), study selection (TX, XQY), data extraction (TX, XQY), and data processing (TX, XQY) independently. Disagreements were resolved by discussion and reaching consensus through third-party (MQG) intervention.

Two-mode network

In TCM practice, the practitioner examines the patient through four diagnostic methods (looking, listening and smelling, asking, and touching) and also uses certain biochemical tests results to reach a Zheng diagnosis. Then the practitioner prescribes a customized TCM herbal formula comprising several herbs to heal the patient. Each herb is prescribed to treat the Zheng. In graph theory, a two-mode network is also called a bipartite graph,[12] in which the nodes are divided into two disjoint sets, U and V. Each edge connects a node in U to a node in V. In our study, the relationships between herbs and Zhengs can be modeled as a two-mode network. The herb node is one mode, and the Zheng node is the other. Each treating relationship between herb and a Zheng is an edge. Fig. 2 shows the relationships in this two-mode network. Edges only exist between herb nodes and Zheng nodes, and there are no edges within the mode.

We classified the data we collected into a node list and an edge list. The node list comprised two sets of nodes; one was a list of all Zhengs, and the other was a list of all herbs. The edge list was a list of edges that connected all Zhengs and herbs. The two-mode network was therefore constructed by the node list and the edge list.

Community detection

Our task was to analyze a two-mode network as described above. Many researchers have used the projection method to transform a two-mode network into a one-mode