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Review Article

Trends in deqi research: a text mining and network analysis

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ABSTRACT

Deqi is a term describing a special state of the human body, which is ready to cure itself through acupuncture stimulation and is believed to be a key factor in acupuncture treatment. However, knowledge about deqi remains subjective. Therefore, in this study, we aimed to determine the factors related to deqi generation based on present studies to promote the progression of deqi research.

A term frequency–inverse document frequency (Tf-idf) was used to extract key elements from the abstracts of 148 articles searched from Pubmed, and the network structure between key elements was analyzed.

A total of 37 items were extracted from the abstracts. Each item was categorized into one of three groups (acupuncture-related sensation, interventions or organ/mechanism). Acupuncture-related sensation was studied by comparing the items in the interventions group with the organ/mechanism group. Key elements related to deqi generation included muscles from the organ/mechanism group and intensity, depth and pressure from the interventions group. Items that belonged to the acupuncture-related sensation group were divided into two clusters: one cluster consisted of pain, tingling, aching, soreness, heaviness, fullness and numbness; the other included warm, cold and dull.

We could find out that the trend of deqi was leaning towards the interventions group, which related to the generation of deqi; thus, authors concluded that the mechanism studies, which are aimed to investigate why deqi is generated or what kind of meanings it has, are needed for evolution of acupuncture theory and application of the brand new technologies and related devices.

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1. Introduction

Deqi is a term describing a special state of the human body during acupuncture stimulation. This state of obscurity means that acupuncture stimulation has been sufficiently delivered to the meridian system, and that the human body is ready to cure itself.[1] Deqi sensation, on the other hand, includes a number of sensations that could be felt by both patients and doctors during acupuncture stimulation and is considered a sign of the deqi phenomenon.[2] Deqi sensation could be classified as a subcategory of deqi; however, many researchers and clinicians confuse these two terms due to the misuse of the terms, which also causes confusion in building a strategy for research studies.

For decades, deqi has been considered as a key issue in acupuncture research because of the possibility of correlations with clinical efficacy,[3] mechanisms of acupuncture treatment[4] or developments of new techniques of acupuncture treatment. The majority of deqi studies have focused on deqi sensation instead of deqi itself[5] because of the absence of objective parameters to quantify the deqi phenomenon despite the importance of deqi research. The absence of deqi parameters is related to the absence of definition for deqi from literature dealing with modern biological interpretation of deqi.[6]

Deqi sensation has been studied according to several themes. The deqi sensation questionnaire has been developed as Massachusetts General Hospital acupuncture sensation scale (MASS),[7] Southampton needle sensation questionnaire (SNSQ)[8] and acupuncture sensation questionnaire (ASQ).[9] Some studies assessed the relation between deqi sensation and quality or quantity of acupuncture stimulation. For the quantity of stimulation, the deqi sensation scale was compared between different levels of stimulation,[10] needle insertion locations[11] or insertion depths.[12] For a qualitative approach, researchers used various stimulation devices such as electro-acupuncture (EA)[13,14] and laser acupuncture (LA).[15]

Others studies have investigated the origin of deqi sensation such as the nervous system[16] or connective tissue.[17] Recently, an fMRI imaging technique was used to uncover the brain areas related to evoking the deqi sensation.[18,19] White[20] and Xiong[3] focused on the relation between clinical efficacy and deqi sensation and concluded that deqi sensation is deeply associated with the clinical efficacy of acupuncture treatment. However, those researches which at the beginning stage showed only superficial data such as the location, which is related with deqi or potentials, need to be advanced to show us what is deqi and what is its value.

In this study, text mining and network analysis techniques have been applied to articles about deqi sensation to extract certain patterns and relations from the variety of hypotheses and conclusions about deqi sensation. This extraction led to further study and clarification of the concepts and mechanisms of Deqi sensation.

2. Methods

2.1. Articles

De-qi, Deqi, De Qi and acupuncture sensation were used as key words to search for articles related to de qi sensation on the Pubmed homepage (http://www.ncbi.nlm.nih.gov/pubmed). A total of 148 articles remained after excluding articles written in Chinese. Only abstracts were used, because full-text articles contained additional descriptions.

2.2. Text mining and network analysis

2.2.1. Tf-idf

Term frequency–inverse document frequency (tf-idf) is an index representing the significance of each term in a document set.[21] Term frequency, tf(t,d)), is the number of occurrences of term t in document d. A higher term frequency indicates a higher relevance. Document frequency df(t) refers to the number of documents that contain the term t, indicating how rare the term is in the document set. A lower document frequency implies that the document is more informative because rare terms are more important than frequent terms in the document set. Thus, inverse document frequency (idf), defined as $\log(N/df(t))$ arithmetically is proportional to the informativeness of t.

T = set of terms, D = set of documents, $t \in T$, $d \in D$, $N = n(D)$
$tf(t,d)$ = #(term t appearing in document d)
$df(t)$ = #(document contains term t), $idf(t) = \log(N/df(t))$
$tf\text{-}idf = Tf(t,d) * idf(t)$

2.2.2. Network construction

We wanted to observe how sensation is represented with stimulation and source. Therefore, network analysis based on tf-idf was conducted. Here, we used conditional tf-idf($a|b$), which is defined as the tf-idf score of term a in documents containing term b.[22]

For each sensation, we included a vector calculated from conditional tf-idf for each stimulation.

$tf\text{-}idf(a|b)$,

where $a \in$ 'sensation', $a \in$ 'stimulation'.

Sensation is represented by a vector space of stimulation. Furthermore, a network is constructed with sensation represented as the nodes, and Euclidean distances of the vector are represented as weighted links. The same progress was conducted with 'source', not 'stimulation'.

2.2.3. Clustering

From constructed networks, modules are defined by clustering. The clustering is performed with machine learning software Weka (Waikato Environment for Knowledge Analysis) version 3.6.13 (The University of Waikato, New Zealand) and the EM (Expectation Maximization) clustering algorithm.[23]

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