CLINICAL OBSERVATION

Data mining-based detection of acupuncture treatment on juvenile myopia

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**Abstract**

**OBJECTIVE:** We applied data mining techniques to the study of acupuncture as a treatment for juvenile myopia, with the aim of identifying hidden patterns in the data.

**METHODS:** Fifty patients with juvenile myopia were selected and treated with acupuncture, and data mining was used to analyze the effects of treatment and the influence of behavioral variables. Clustering analysis was used to divide myopia patients into two classifications before acupuncture treatment. Artificial neural network BP algorithm was adopted to analyze the roles of different factors in changes in diopters. An association algorithm was used to analyze factors associated with the subjective experience of acupuncture and average diopter.

**RESULTS:** The two classification results were fully consistent with the understandings of the ophthalmic circles. The duration of using the Internet and watching TV every day was the main factor that affected vision. Acupuncture feelings and therapeutic effect have a strong correlativity. A good or above experience's score of acupuncture could slow the progression of juvenile myopia.

**CONCLUSION:** Collecting data from patients with juvenile myopia by using data mining can extract hidden potential rules and knowledge from the research evidence. The decision support can be provided to improve the doctor's clinical acupuncture treatment effects.

INTRODUCTION

According to recent surveys at home and abroad, China has one of the highest incidences of myopia, and the incidence of juvenile myopia is increasing. Previous studies of myopia have been limited to modern evidence-based ophthalmology. So far, modern medicine has not only failed to find a cure for myopia, but it has also failed to find a feasible way of controlling its development. Therefore, it is important to explore the effectiveness of treatments and prevention methods for true myopia, especially high myopia, which has important medical and social consequences. Acupuncture can treat a variety of eye disease; the theoretical basis of this treatment is the relationship of the eyes to the 12 meridians. In acupuncture, clinical evidence-based diagnosis and treatment decision-making analysis have...
focused on two aspects. The first is based on the patient’s signs and symptoms for diagnosis, resulting in a dialectic treatment decision. The second relies on analysis of the known rules of acupuncture and efficacy of acupuncture, thoracic moxibustion, treatment time, and other relevant factors, to decide on the optimal treatment solution.11 The foreign ophthalmic industry has used decision tree analysis to find patterns regarding risk factors for eye deterioration in large datasets.12 The domestic ophthalmic industry using Chinese medicine regards ophthalmology as “one of the hardest parts in TCM”, and believes in the use of data mining methods to study the effectiveness of TCM in ophthalmology.13 In this study, we used the association rule learning method of data mining using data acquired during acupuncture treatment of juvenile myopia. We aimed to find hidden associations within the data, in terms of treatment options, treatment efficacy, and influence of co-existing medical conditions. We verified through experiments the effectiveness of acupuncture treatment in juvenile myopia, and explored new information on how to further optimize treatment and prevention measures.

METHODS AND ALGORITHMS

Patient selection and data collection
Fifty patients with true juvenile myopia were selected according to the textbook Chinese medicine Ophthalmology.14 The treatments were chosen based on the following principle: promoting flow of Qi and blood circulation, relaxing muscle and tendons, and improving the eyesight. Stimulation of eye acupoints can regulate the functions of meridians of eyes and zang-fu organs.15 The acupuncture points Cuanzhu (BL 2), Taiyang (EX-HN5), Qiuhou (EX-HN7) and Sibai (ST 2) are located around the eye area, and their stimulation can clear blockages and regulate the blood flow and meridians. Hegu (LI 4) is the original acupoint of the large intestine meridian of hand-yangming. Needling can agitate Qi and blood in the face near the eye area, promoting Qi and blood flow and improving eyesight. Baihui (GV 20) belongs to the Dumai (Governor Vessel) and meets with the bladder meridian of foot-taiyang. Thus, acupuncture stimulation of Cuanzhu, Taiyang, Qiuhou, Sibai, Baihui and Hegu has an effect in the treatment of juvenile myopia. We collected clinical data at 1, 2, 3 and 4 months from the start of the treatment, using several eye examination tests, including visual acuity, intraocular pressure, refraction, horizontal corneal curvature, vertical corneal curvature, axial length, lens thickness and depth of anterior chamber and vitreous matter. Other indices based on self-designed “acupuncture treatment of juvenile myopia focus on the object of study follow-up survey table” were collected as the source data for data mining.

Data mining algorithms
Knowledge of the association is to reflect the knowledge of the dependence or association between events in a data set. The important feature of association rules is an “association natural combination”, which found that a subset that existed mode of all the attributes is very useful.16 17 The purpose of clustering is reasonable according to certain rules of classification or clustering, and with the explicit or implicit method to describe the different categories. By digging the hidden implicit knowledge in the treatment of information, it can provide decision support for the improvement of the doctor’s clinical acupuncture treatment. An artificial neural network BP algorithm can approximate any nonlinear curve. To identify which factors are associated with the patient’s average diopter change, the network is given a set of inputs and corresponding outputs and determines the parameters of each neuron by analyzing the relationship between the input and output.18 In previous research, multiple stepwise regression analysis has been applied to the quantitative analysis of factors influencing the response to treatment in patients receiving acupuncture for juvenile myopia. Each patient has a unique optimal equation, and by studying the model, we can obtain the weights of factors determining visual acuity.19-22 Acupuncture doctors need as much information as possible about the patients and treatment, so that they can adjust the acupuncture treatment or adopt other effective measures based on the relevant factors in the optimal equation of each patient. This provides a more targeted way of selecting an appropriate acupuncture treatment program early on in the clinical course, and also provides a more reliable means of tracking the progress of treatment and assessing the therapeutic effect.

DATA MINING ANALYSIS

Questionnaire on the impact of juvenile myopia during acupuncture treatment
During acupuncture treatment of juvenile myopia, patients were required to complete “the focus on object tracking questionnaire”. Questions were related to whether the parents suffered from myopia, the daily burden on the eye, amount of time spent on the Internet and watching television each day, reading time, writing time, reading posture of the patients, usual time spent on homework, the subjective experience of acupuncture, whether the patient likes sweets and fried food, and other questions. The extracted information was encoded in the table as follows. Parental myopia: “0” indicates “no myopia”, “1” indicates “myopia”; learning environment: “0” indicates “good”, “1” means “poor”; reading position: “0” indicates “good”, “1” means “poor”; eating habits: “0” indicates “good”, “1” means “poor”; time spent on the Internet and watch-
ing TV: the number of hours/day, such as "1", "2", etc.; subjective experience of acupuncture: rated on a scale from 0 to 4, where "4" means "very good", "3" means "good", "2" means "effective", "1" means "neutral" and "0" means "poor"; time spent reading/writing: the number of hours/day, such as "1", "2", etc. Assessment of the learning environment and reading posture was based on the Shanghai Municipal Education Commission promulgated "two requirements for do" and "another two requirements for donor" of "protection eyesight, the prevention of myopia and hygiene knowledge", to determine "good" and "bad".

Cluster analysis of factors associated with juvenile myopia before acupuncture treatment

The patients were classified according to an ophthalmologist recommendation obtained before the acupuncture treatment.21,24 We were helped by Chinese ophthalmologists to understand the patients' condition before the acupuncture treatment, taking acupuncture treatment for targeted prescription, and doing targeted therapy. Maximum expected value of the soft clustering method, a closed curve as the clustering criteria set in each dimension, and calculate the mean and standard deviation. If a point falls on the closed curve, then there is a certain probability of the point belonging to the given classification. In addition, because the classification of the corresponding curve is not unique, some points are likely to fall into more than one classification curves; these were assigned a probability value. We used "ID" as the key and "parents myopia", "reading posture", "eating habits", "eye time" and "Internet TV" as the input. The average Δ diopter was the predictable variable. Because the "learning environment" was classified as "good" in all cases, this variable was not included. The clustering result showed that the 50 patients were divided into two classifications, with 24 patients in classification 1, and 26 patients in classification 2.

In the Microsoft SQL Server 2008 Analysis Services (SSAS), before acupuncture treatment, cluster analysis algorithm can get classification's characteristics as follow. The main variables impacted by myopia were: "reading position" (94%), "parents' myopia" (80%) and "eating habits" (72%). The classification and comparison is shown below. At the same time, the classification and comparison shows a daily "eye time" of two hours, Internet/TV time of two hours and parents with myopia favored classification 1, while a daily "eye time" of three hours, Internet/TV time of three hours and no myopia in parents favored classification 2. Further analysis showed that patients with juvenile myopia could be divided into two groups: one without the genetic component and including patients with long-duration (>3 h) eye time, and one consisting of patients with eye time of ≤s2 h but with myopic parents. These results are in agreement with the current views of the ophthalmic industry.25

Effect of behavioral factors on the average diopter change during acupuncture treatment

In the sample of 50 juvenile myopia patients, four months of acupuncture treatment was associated with an average diopter change in some patients but not others. However, during acupuncture treatment, the patients had their own lives, learning habits and behaviors, and all these factors may affect the average diopter change. The data concerning "Internet/TV", "parents' myopia", "eating habits", "reading position" and "eye time" are shown in Table 1 together with the left and right eye average diopter change.

<p>| Table 1 Living habits and average Δ diopter |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>NO</th>
<th>Gender</th>
<th>Date of birth</th>
<th>LID</th>
<th>Δ L Diopeter</th>
<th>Δ R Diopeter</th>
<th>Parents' myopia</th>
<th>Eating habits</th>
<th>Reading position</th>
<th>Eye time</th>
<th>Internet TV</th>
<th>The average Δ diopter</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>NO.1</td>
<td>M</td>
<td>1998.11.26</td>
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<td>0</td>
<td>-0.25</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>-0.125</td>
</tr>
<tr>
<td>2</td>
<td>NO.2</td>
<td>F</td>
<td>1999.12.1</td>
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<td>0</td>
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<td>3</td>
<td>1</td>
<td>-0.375</td>
</tr>
<tr>
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<td>NO.3</td>
<td>M</td>
<td>1997.11.20</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
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<td>0</td>
</tr>
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<td>4</td>
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<td>F</td>
<td>1988.27</td>
<td>4</td>
<td>-1.25</td>
<td>-0.75</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>-1.00</td>
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</tr>
</tbody>
</table>

Using a BP algorithm of artificial neural networks,26 with ID as the key, "Internet/TV", "eye time", "parents' myopia", "eating habits" and "reading position" as the input, and "average Δ diopter" as a predictable output. Using the output attribute "average Δ diopter" and Value 1= - 0.375 and Value 2=0 as an example, since there are different input attribute values associated with the two output attribute values, we select the first two input attributes that most strongly affect the output attribute as the main influencing factors. That is, the input attribute "Internet/TV=0" favored output attribute "average Δ diopter= - 0.375" with a score of 100%. The input attribute "eye time=3" favored output attribute "average Δ diopter= - 0.375" with a score of 67.9%. Similarly, the input attribute "eye time=4" favored output attribute "average Δ diopter=0" with a score of 63.52%, and "Internet/TV=3" favored "average Δ diopter=0" with a score of 39.34%. As a result, we mined the data generated by analysis of SSAS as shown below Table 2.
Table 2 shows how when a value is specified for the input variables, it affects the score of the output variables. For the input attribute value "Internet/TV", there were seven occurrences of scores, for "eye time" there were six scores, for "eating habits" three scores, and for "parents myopia" and "reading posture" there was one score. Therefore, the main factor affecting the diopter change in juvenile myopia is time spent on the Internet and watching TV, and this is followed by "eye time". Furthermore, visual acuity was also affected by a preference for fried food and sweets, the presence of parental myopia, and a bad reading posture. At this point, it is recommended that patients with juvenile myopia combine labor with rest and watch their diet, to protect their own vision.

**Association analysis of the subjective experience of acupuncture in visual acuity change**

After the end of the four courses of acupuncture treatment, the doctors hope to be able to know the role of acupuncture in the treatment of myopia. We used an association algorithm with the "ID" as the key, "experience of acupuncture" as input and "average Δ diopter" as a predictable variable. When the minimum probability was set to 0.64 and the lowest importance to 0.26, it resulted in three association rules. According to dependency network (from strongest to weakest link): experience of acupuncture<0.9196 à average Δ diopter=-0.6918 to -0.0592; experience of acupuncture=2.7499-3.1599 à average Δ diopter≥-0.0592; experience of acupuncture≥3.1599 à average Δ diopter≥-0.0592. This shows that when the experience of acupuncture was neutral (score~1), the diopter increased relatively quickly, whereas when the experience of acupuncture was good (score~3), the diopter increased more slowly. This indicates that acupuncture treatment prevents the development of myopia, in particular when the experience of acupuncture is "good" or above. Association analysis thus showed that there was a strong association between the experience of acupuncture and therapeutic effects. The subjective experience of acupuncture can be used to determine whether a patient needs to receive individualized treatment, such as scalp or ear acupuncture, for a more targeted effect.

**SUMMARY**

We studied 50 cases of juvenile myopia during four months of the acupuncture treatment, by using myopia detection data, data mining and knowledge acquisition. Before the acupuncture treatment, cluster analysis resulted in the classification of myopia patients into two groups, which is fully consistent with the views of the ophthalmic industry. After acupuncture treatment, we used an artificial neural network BP algorithm to analyze the diopter change during treatment and to analyze the influence of different behavioral factors, finding that the duration of using the Internet and watching TV every day was a main factor that affected vision. Therefore, patients should be persuaded to avoid television and Internet as far as possible to protect their vision. We also found that there was a strong correlation between the subjective experience of acupuncture and the effect of treatment, whereby a good experience of acupuncture could slow the progression of juvenile myopia. To enable patients to have a good experience of the acupuncture treatment, the optimal equations gained by a multiple stepwise regression analysis algorithm can be used to find the main impact indicators. This enables the selection of the best acupuncture prescription or individualized treatment. However, if patients are genuinely unable to reach the "good" level,
they should be persuaded to terminate the treatment, so as not to waste human and material resources.

REFERENCES
7 Wu YL. Young people how to protect their eyesight. Chinese ophthalmology 2007; 13(9): 1260-1261.