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Study on Risk Factors of Mild Cognitive Impairment: Based on Decision Tree Model

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Abstract: **Collect demographic, life and clinical factors of patients with mild cognitive impairment(MCI), analysis of MCI factors and set up high-risk factors model by use the decision tree data mining methods. 380 patients were selected from our hospital department of health and neurology clinic or hospital treatment during October 2014 to October 2016, The demographics, living habit of patients and Clinical factors were collected, C5.0 decision tree algorithm was adopted to establish the mild cognitive impairment risk factor prediction model, use the Logistic regression analysis and chi-square to assist the decision tree model. According to the decision tree model, the model prediction accuracy was 78.95%, age was the most important variable factors for MCI, sleep, exercise, diabetes, education, drinking were important variables to MCI. According to result of Logistic regression analysis, age, drinking, sleep were independent risk factors for MCI, the model prediction accuracy was 66.32%, results had significant difference (P<0.05). The decision tree model was superior to logistic regression model in the prediction accuracy for MCI happened, age, diabetes, drinking, insomnia were risk factors for MCI, exercise and education were the protective factors for the MCI.**

Keywords: Mild cognitive impairment(MCI); Rsk factors; Decision tree; Prediction model

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1. Introduction

With the population aging, the number of cognitive impairment patients was increasing year by year. Meanwhile, there was no effective treatment method for the disease. Mild cognitive impairment (MCI) was an unstable state of cognitive impairment between normal aging and dementia, it can be improved or progression to dementia [1]. Therefore, the research of mild cognitive impairment was of important significance to the early diagnosis and preventing, and it has become a hot research recently. Now prevent and control of MCI based on clinical experience, but it contains too many subjective elements, and lack of quantitative, so it was difficult to predict the disease of MCI by the traditional warning model. Traditional warning model was difficult to realize the function of entirety, complexity, dynamic and nonlinear synergies among the risk factors. Data mining was a practical branch of artificial intelligence which discovers latent patterns through looking for relationships between features in large databases. Decision tree was one of data mining methods used in the various studies in the health sector in order to build prediction models. Decision trees based on real-life data were promising because they could detect previously unknown interactions between the various items of clinical information and reveal relationships between assessment outcomes and patient characteristics. The decision tree model can make up the defects and insufficiency in the traditional analysis method [2]. The purpose of this study was setting up the prediction model for mild cognitive impairment via C5.0 decision tree algorithm. Through the decision tree analysis different factors of MCI and predict the cognitive impairment.

2. Object and Methods

2.1. Object

The study data set comprises all in-patient episodes from October 2014 to October 2016, 380 patients were selected from our hospital department of Geriatric medicine and neurology, outpatient or hospitalization. According to the cognitive function and daily activities damage divided into mild cognitive impairment group (166 cases) and cognitive normal controls group (214 cases), obtained informed consent before surveying, and patients or their families are signed informed consent. There was no exact consistent MCI diagnosis standard at home and abroad, widely used diagnostic criteria was Petersen diagnostic criteria, inclusion criteria: (1) Complained of memory loss, and memory difficulties confirmed by family members or others; (2) Mini Mental State Examination (MMSE) scored 24 to 30; (3) Hachinski ischemia index score <7, CDR was equal to 0.5, memory items score must be at least 0.5 points; (4) the normal activities of daily living; (5) Hamilton Depression Rating Scale score ≤12 points (17 items); (6) did not meet the criteria of dementia. Exclusion criteria: (1)consciousness impairment; (2) aphasia, severe hearing and visual impairment; (3)serious heart, lung, liver, kidney and other diseases; (4)with previous history of psychiatric disease, and so on. The cognitive normal controls (NC) diagnostic criteria refered to previous literature [3].

2.2. Methods

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(1) Lifestyle questionnaire was made by ourselves, contents include demographic, life and clinical factors. It refers to the "mild cognitive impairment questionnaire of diagnosis and intervention", that used in national "Eleventh Five-Year" Technology Support Program. Factors content: sex, age, educational, smoking, drinking, exercise, sleep, hypertension, diabetes, hyperlipidemia. (2) Evaluation of cognitive function: applied the table of MMSE, Hachinski, CDR and risk factors in lifestyle to evaluation cognitive function. Boban's study shows that sensitivity and speciality as high as 95% and 94.44% respectively when MMSE as MCI screening tool, and it has high reliability. (3) The composition of investigate: It was consisted of experienced clinical doctors and graduate students in geriatrics. Firstly it was qualified training prior to the survey by unified questionnaires and standardized language to survey. The questionnaire participants were completed by reading, verbal answer way for illiterate or unable to independently complete the questionnaire (can't see the word).

2.3. Statistical analysis

All variables are unified quantization and coding (Table 1), SPSS Modeler 14.1 and SPSS 22.0 statistical software was used for data processing and analysis. Analysis data by C5.0 decision tree algorithm and logistic regression, $P<0.05$ as significant meaning.

Table 1 Assignment all the risk factors of MCI

Factors	Assignment
sex	Male=1；Female=2
Age	≤78 years=1；＞78 years=2
Educational	Middle school and above=1；Primary school group=2；Illiteracy group=3
Hypertension	Existence=1；Inexistence=2
Diabetes	Existence=1；Inexistence=2
Hyperlipidemia	Existence=1；Inexistence=2
Smoking	Existence=1；Inexistence=2
Drinking	Excessive drinking =1；No drinking=2
Exercise	Inexistence=1；Existence=2
Sleep	Normal=1；Insomnia =2
VCI	MCI=1；Normal =2

3. Results

3.1. The results of decision tree model

According to the decision tree model, the model prediction accuracy was 78.95%, age was the most important variable factors for MCI， the MCI probability of more than 78-year-old people was 70.77%, while the MCI probability of less than 78-year-old people was 38.09%. Sleep、exercise、diabetes、education、drinking were important variables to MCI. In the crowd of more than 78-year-old, the MCI probability in people with insomnia was 88.46%, and the MCI probability in people with normal sleep was 58.97%. In the crowd of less than 78-year-old, the MCI probability in people with insomnia was 54.08%, and the MCI probability in people with normal sleep was 30.88%. People with insomnia younger than 78-year-old, the MCI probability in people who did exercise (31.43%) less than the people did not exercise (66.67%), and the MCI probability in people who excessive drinking(71.43%) more than the people who did not drink(21.43%) among people did exercise, it also found that with the increasing of the education level among people did not exercise, the incidence of MCI significantly decreased (83.33% for illiterate, 73.08% for primary, 21.43% for middle school and above). Through the decision tree model, age、diabetes、drinking、insomnia were risk factors for MCI, exercise and education were the protective factors for the MCI (Figure 1).

3.2. The results of Logistic regression analysis

According to result of Logistic regression analysis, age, drinking, sleep were independent risk factors for MCI, the Logistic regression model prediction accuracy was 66.32%. Advanced age、excessive drinking, insomnia lead to MCI probability increases (Table 2).

4. Discussion

In recent years, the old people's risk factors on cognitive impairment attracted more and more attention. According to the decision tree model, age was the most important variable factors for MCI，the MCI probability of more than 78-year-old people was 70.77%, while the MCI probability of less than 78-year-old people was 38.09%. With our county population aging, more and more people appear cognitive impairment. Age was a key risk factor for cognitive impairment, just as the previous studies [4-5], more than 80-year-old in the elderly has a significantly lower cognitive function. Aguilar-Navarro SG [6]

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investigated clinical and demographic predictors of conversion to dementia found that age was predictor of conversion to dementia, multivariate Cox regression analysis showed that progression to dementia was associated with age (HR:4.95;95% CI:1.96-12.46; P=0.001).

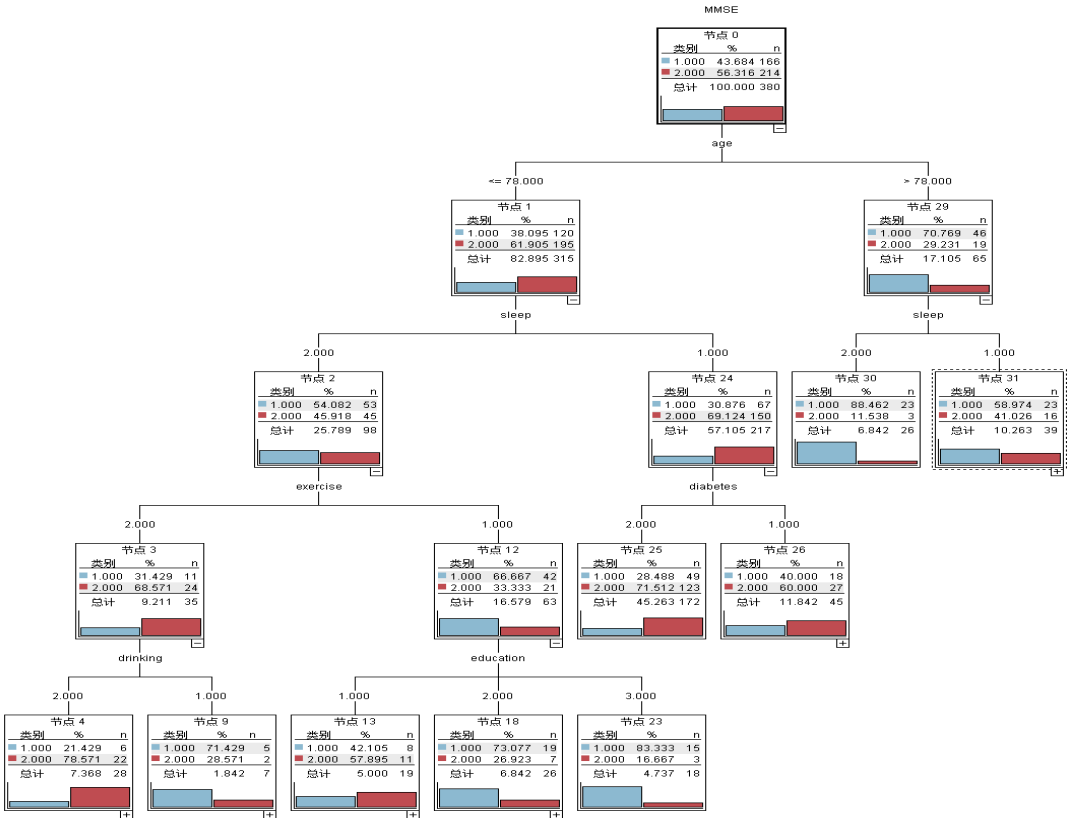

Figure 1. Decision tree model.

Sleep as a protective inhibition for the body, which can make the fatigue of nerve cells restore to normal physiology function, ensure nervous system had normal function. Insomnia was a kind of mental disease, often insomnia could cause variety of physical or mental illness. According to the second floor of the decision tree model, in the crowd of more than 78-year-old, the MCI probability in people with insomnia was 88.46%, and the MCI probability in people with normal sleep was 58.97%. In the crowd of less than 78-year-old, the MCI probability in people with insomnia was 54.08%, and the MCI probability in people with normal sleep was 30.88%. No matter how old the people, the incidence of MCI in people with insomnia was far greater than the people with normal sleep. Some studies had found that [7] patients with insomnia had cognitive functions damage such as memory, attention, executive function, the length of insomnia, severity of illness, comorbid anxiety or depression were related factors that lead to cognitive impairment. Some people think that insomnia was not conducive to protein synthesis in brain and established new synapses, leading to cortical cognitive potential change and cognitive impairment finally [8].

According to the third floor of the decision tree model, people with insomnia younger than 78-year-old, the MCI probability in people who did exercise (31.43%) less than the people did not exercise (66.67%). This result showed that the exercise made the risk of MCI reduce. Some research had proved that sports may promote the cognitive function through regulating the neuron activity associated with cognitive function、 neurotransmitter release, related gene expression and antioxidant capacity in brain tissue. Exercise can also improve cardiovascular function to improve cognitive function [9]. If daily activities of elderly people were less, a variety of information received was less and the necessary stimulation maintained normal function of the brain was corresponding reducing, so cognitive ability declined gradually; On the contrary, the increasing of exercise could delay and prevent the risk of cognitive impairment [10]. A number of follow-up study [11] show that information processing speed、working memory, attention and executive function decline in people with diabetes, cognitive impairment affect patients with diabetes self-management ability of blood sugar levels, causes the increased incidence of cerebrovascular complications and hypoglycemia events, further worsen cognitive dysfunction. The mechanism of diabetes complicated with cognitive impairment has not yet been elucidated, that may be associated with factors of polyol pathway, AGEs, oxidative stress, nitric oxide and autophagy、nerve inflammation and so on [12-13].

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Table 2 Logistic regression analysis results of MCI risk factors

	B	S.E.	Wald	P	Exp(B)
age	-1.011	0.260	15.123	0.000	0.364
drinking	-0.912	0.334	7.472	0.006	2.490
sleep	-1.198	0.251	22.750	0.000	0.302

And we found from the decision tree model that the MCI probability in people who drinking (71.43%) more than the people who did not drink (21.43%) among people did exercise. It is clear that the excessive drinking was a risk factor for cognitive decline. Stampfer's study [14] found that moderate drinking had protective effect on cognitive function, it may improve blood circulation and prevent oxidative damage, protect the cognitive abilities in the brain [15]. However, we did not suggest people without drinking habit always drinking, because alcohol could cause shrinking in hippocampus, amygdala, cingulate and frontal lobe, affected Cholinergic and 5-tryptamine transmit, long-term excessive drinking could also lead to the lack of vitamin B1, these factors were directly or indirectly damage the cognitive function.

We also found that lower-education level was risk factors of MCI. With the increasing of the education level among people did not exercise, the incidence of MCI significantly decreased (83.33% for illiterate, 73.08% for primary, 21.43% for middle school and above). The cases whose educational level was lower were more likely to develop MCI than those who had higher educated, just as the study of Tervo [16], whose found that lower-education level was risk factors of MCI. In addition, Xu Wenwei research [17] show that studying at the elderly university may produce positive effects on cognitive function in the elderly, it may be the process of accept education increased oxygen and glucose that necessary for neural activity, at the same time also increased the cerebral blood flow, cause nerve damage of self-protection ability enhancement, and finally reduces the occurrence of dementia.

According to result of Logistic regression analysis, age, drinking, sleep was independent risk factors for MCI. Unlike the logistic regression analysis, in other factor analysis by decision tree model also shows the importance, for example, exercise, diabetes, education not reflected in the Logistic regression analysis. The decision tree model could more intuitive, image reflect the characteristics of the MCI subsets and reflect the importance of the risk factors compared with Logistic regression analysis. The decision tree model can reveal the importance of each risk factor in MCI and what characteristics of a higher percentage of MCI group, it had more practice significance than only analysis variables affect the result, and would not missed meaningful variables as the collinearity among the independent variables. Classification via risk factors for the people with MCI, it could found different groups that had different risk factors so that guide clinical and auxiliary diagnosis. In order to prevent excessive data fitting for decision tree model, in the future should be expanded sample size multicenter comparison and improve the credibility of the model finally.

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