Visualization Analysis Technology and Application of Mass Spectrometry Data in the Analysis of Traditional Chinese Medicine

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Abstract: Spectral effect related research is a new method to explore the material basis of traditional Chinese medicine and effectively control the internal quality of traditional Chinese medicine. In recent years, scholars have applied this method to the extensive research of traditional Chinese medicine and its compound, and achieved some results. In this paper, the application of spectral effect correlation research methods in the material basis research of traditional Chinese medicine was summarized, on the basis of which the characteristics and application attention of various correlation analysis methods were discussed, and the existing problems in the current research were discussed. It provides a reference for scientific and reasonable selection of spectral effect correlation analysis method suitable for the characteristics of traditional Chinese medicine.

1. Introduction

Mass spectrometry (Mass Spectrometry, MS) is a method to determine the quality of each component by measuring the charge ratio of ions. It is widely used in medicine, chemical industry, environment, energy, criminal science and technology, material science and other fields. With the development of recent years, the sensitivity of mass spectrometry has been significantly improved by the innovation of technology. at present, the detection limit has reached the Pimol, flying molar level [1]. In the field of medical biology, combined with gas phase, liquid phase, capillary electrophoresis and other techniques, mass spectrometry has realized the length of proteomics, lipid histology, metabonomics, new drug development and medical diagnosis. In the related research of traditional Chinese medicine, it has also changed from single molecule detection to qualitative and quantitative analysis of the same kind of compounds in the sample, or many kinds of compounds. The rapid growth of the original data volume of mass spectrometry requires the corresponding analysis process to be further optimized and the efficiency of data analysis to be further improved in order to meet the analytical requirements of complex samples under the background of new technology. Fingerprint or characteristic map, as a comprehensive and quantitative quality control method, has the characteristics of integrity and fuzziness [2]. In recent years, it has been widely recognized at home and abroad for the quality control of traditional Chinese medicine. However, some scholars believe that only by the simple chemical information in the map. It is difficult to really control the curative effect of traditional Chinese medicine, and the changes of chemical components in the map need to be related to the efficacy. In this paper, the research methods used by scholars in the spectral effect related research of single traditional Chinese medicine and traditional Chinese medicine compound (including drug pair) in recent years are summarized in order to find out the law and provide reference for the future spectral effect related research.

2. Summary of Mass Spectrometry Analysis

Through the analysis of the above research status, it can be seen that the "spectrum" usually refers to the fingerprint or characteristic map in the spectral effect related research of traditional Chinese medicine at present, and the main methods of obtaining it are HPLC or UPLC and their combination technology [3]. The establishment of "fingerprint" of traditional Chinese medicine is generally composed of chromatogram acquisition and similarity evaluation. The ultimate purpose of similarity evaluation is to distinguish whether the sample is true or false and whether it is qualified

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or not by comparing the sample chromatogram with the control map. That is, quality control [4]. At present, the concept of characteristic map of traditional Chinese medicine has not been clearly defined. It is generally believed that after obtaining the chromatogram of representative medicinal materials, compound or preparation, it is generally believed that after obtaining the chromatogram of representative medicinal materials, compounds or preparations, The map is characterized by over-identification and marking of common peaks (sometimes unstable characteristic peaks are also taken into account). According to the relevant regulations of the National Pharmacopoeia Commission "Technical Guide for Experimental Research on fingerprint of traditional Chinese Medicine injection (trial)", it is necessary to evaluate the similarity of chromatogram before it can form fingerprint. Therefore, the characteristic map can be regarded as the "predecessor" of the fingerprint, and its concern is not the similarity of the chromatogram of each batch or producing area, but the chromatographic peak which can be stably expressed and can not be stably expressed. It is more beneficial to study whether the chemical composition is present or not, and how much it affects the efficacy, and is more suitable for the discovery and study of the effective substances. [5]。 The concept of "effect" in the spectral effect correlation of traditional Chinese medicine refers to "the efficacy of traditional Chinese medicine". The choice of efficacy index is mainly determined by the specific drugs studied and their sexual and flavor effects. in the practical research, we should try our best to select classical, simple and sensitive detection methods, and pay attention to the selection of pharmacodynamic indexes which can represent the main efficacy of traditional Chinese medicine. At present, the method of in vitro experiment is more used to obtain the drug effect data.

3. Analysis Method of Spectral Effect Correlation Application

At present, a variety of correlation analysis methods have been applied to the study of spectral effect of traditional Chinese medicine, each method has its characteristics and scope of application. In practice, it should be selected according to the nature and expected objectives of the research object, and should be reasonably applied [6]. The principles and characteristics of various methods are summarized as follows.

3.1. Correlation analysis

This is a statistical analysis method to study the correlation between random variables. According to the correlation form, it can be divided into linear correlation and nonlinear correlation. Linear correlation analysis includes bivariate correlation analysis, partial correlation analysis and distance analysis. Through the correlation analysis between the relative peak area or the relative content of the chromatographic peak and the efficacy index, the correlation coefficient between the corresponding components of each chromatographic peak and the efficacy index can be obtained. There are many correlation coefficients, among which Pearson (Pearson) correlation coefficient is widely used. Most of the correlation analysis is realized by SPSS statistical software. When there is a nonlinear correlation between variables, most of them are non-linear. Linear regression method was used for analysis. In the study of spectral effect correlation, the correlation coefficient can be obtained by correlation analysis, and the effect of the corresponding components of chromatographic peak on the efficacy can be judged intuitively, but the correlation coefficient is the calculation result of the variable pair between each chromatographic peak and the drug effect composition. Neglects the joint action of many kinds of components, lacks the systematicness.

3.2. Regression analysis

Based on the observed data, a certain dependence between variables is established, and the inherent law of the data is analyzed, which can be used for control, prediction and other problems [7]. Since there is more than one common peak or characteristic peak in the fingerprint, the relationship between "spectrum" and "effect" should be regarded as a problem of multiple regression analysis, including multiple linear regression and multiple nonlinear regression. In the multivariate linear regression analysis, because there are many chromatographic peaks in the

fingerprint or characteristic map of traditional Chinese medicine, if all the regression equations are introduced, not only the amount of calculation is large. And because of the multiple collinearity between independent variables (there is an approximate linear relationship between some or all independent variables), it will make The regression coefficient is unstable and difficult to explain. Therefore, stepwise regression analysis is often used in the study of spectral effect correlation when the components are complex. At present, multiple linear regression analysis is often realized by SPSS software. When there is multiple collinearity between independent variables or when the number of samples in the model is less than the number of independent variables, the general multivariate linear regression analysis is no longer applicable, and the partial least square regression analysis method can be used. This method can not only solve the above problems, but also deal with the modeling problem of multiple dependent variables to multiple independent variables (that is, partial least square path model), and realize the comprehensive application of various analysis methods, including multivariate linear cycles. Regression analysis, principal component analysis and canonical correlation analysis.

3.3. Neural network analysis

Based on the research results of neuropsychology and cognitive science, a processing method with high parallel computing ability, self-study ability and fault-tolerant ability has been developed by using mathematical method. At present, the most widely used error reverse transfer learning algorithm (BackPropagation,BP), that is, BP neural network algorithm. By constructing the input layer neurons, the output layer neurons and the hidden layer, the fingerprint data are correlated with the pharmacodynamic data, and the system model is established, which can be applied to the prediction of drug efficacy results and to the discovery of effective substances. However, because of the fixed learning rate of the neural network, in order to obtain stability, In order to determine a reliable model, a large amount of data is needed in the early stage, and it is difficult for the small sample size experiment to be used for the training of the model for a long time. At present, neural network analysis is mostly realized by Matlab software.

3.4. Grey correlation degree analysis

From the grey system theory. The basic idea is a kind of relative ranking analysis, which judges whether the relationship is close according to the similarity degree of the geometric shape of the sequence curve. Grey relational analysis provides a quantitative measure for the development and change of a system, and is very suitable for dynamic process analysis. However, the grey correlation degree analysis belongs to fuzzy estimation, and the obtained data are incomplete and unreliable, which can only be used as the intermediate link of the research and are not suitable for the establishment of spectral correlation model. Therefore, the selection of this method should be considered in combination with the purpose of the study. Grey Relational Analysis Software GreyModeling Soft can be used for Grey Relational Analysis Each version of ware (GM) or Matlab software implementation.

3.5. Cluster analysis

Clustering analysis is a method of clustering samples from data sets to realize classification. Classical clustering analysis includes system clustering, dynamic clustering and fuzzy clustering. Systematic clustering is one of the most widely used methods in clustering analysis. Systematic clustering can be used in all variables and samples with numerical characteristics. Cluster analysis is suitable for classification problems without prior knowledge, and can be used to deal with the classification determined by multiple variables, and the results are simple and intuitive. However, when the sample size is large, it is difficult to obtain the clustering results. Secondly, cluster analysis is essentially the result of mathematical calculation of numerical variables, which can not identify the reality of the things under analysis. Whether there is an internal relationship, so in some cases, the results of cluster analysis may not be meaningful. Cluster analysis is mostly realized by SPSS,SAS,Matlab and other software.

3.6. Principal component analysis

By using the idea of dimension reduction, a few independent principal components (such as m, m < p) are formed by linear transformation of multiple interrelated variables (such as p), but most of the information in the original data is preserved. For further analysis, most of them are used in combination with cluster analysis, correlation analysis or regression analysis. Principal component analysis can be realized by a variety of mathematical statistics software, in addition, SIMCA-P software can also be used for principal component analysis.

4. Selection and Determination of Pharmacodynamics Indexes

At present, there are too general and untargeted problems in the choice of indicators. This is related to the emphasis on the overall regulation of traditional Chinese medicine (TCM) and its extensive effect. At the same time, it is not very clear about the pathogenesis of the disease. At this stage, there is a lack of animal model which can better reflect the characteristics of TCM syndromes and recognized, exclusive and high sensitivity indicators with the model [8]. Therefore, the exploration of the pathogenesis of the disease should also be deepened, on the basis of a more clear mechanism of action of traditional Chinese medicine, select more targeted efficacy indicators to carry out spectral effect related research. At the same time, because the traditional Chinese medicine compound emphasizes the whole regulation, therefore, the whole animal experiment should be selected as far as possible in the study. The model and detection index should conform to the theoretical characteristics of traditional Chinese medicine, and standardize as much as possible to ensure the consistency and stability of the research results. In addition, most of the spectral effect correlation studies are directly related to the pharmacological indexes at the whole or in vitro tissue and cell level, and do not involve the complex in vivo ADME process and the interaction of various components. In fact, in the study of pharmacokinetics-pharmacokinetics binding model (PK-PD binding model) of traditional Chinese medicine, it was found that the maximum pharmacological effect of some traditional Chinese medicine might occur before or after the peak of blood concentration, that is, "effect". There is no real-time corresponding relationship between the size of the drug and the level of the blood concentration, and the blood concentration is often greatly affected by the dose (which can be expressed by "spectrum"), which fully reflects the characteristics of multi-component and multi-target of traditional Chinese medicine. This situation makes it difficult to determine when to obtain the "effect" in the spectral effect related research. If it is not paid attention to, the results may not reflect the true situation of the spectral effect correlation. When following the characteristics of traditional Chinese medicine, using multi-component and multi-index spectral effect correlation analysis to screen the effective substances of traditional Chinese medicine, we may encounter the problem of conflict between multiple drug efficacy indexes. At this time, a reasonable multi-objective optimization calculation method should be adopted to find In order to realize the discovery of the effective material basis in accordance with the characteristics of traditional Chinese medicine, we can find out the composition and proportion of the components that can make multiple drug indexes close to the comprehensive optimal composition.

5. Conclusion

The related research on the spectrum and effect of traditional Chinese medicine is of great significance to the quality control of traditional Chinese medicine and the discovery of the material basis of drug effect. At present, there are many research methods in this field, but due to the small number of research cases, the universal law has not yet been found out, which still needs to be further explored. With the continuous expansion and deepening of the related basic work, such as pharmacology, drug chemistry, drug analysis and so on, and the mature techniques and methods to solve similar complex problems in other fields, The research on the spectral effect of traditional Chinese medicine is bound to become a powerful means to reveal the material basis of the efficacy

of traditional Chinese medicine, and to promote the modernization and internationalization of traditional Chinese medicine. Play a greater role in the process.

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