Predict the Results of Conservative Therapy for Lumbar Spinal Stenosis--Using Data Mining Technology

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Introduction

In 1988 through 2001, over 200,000 people in USA were suffered from Lumbar spinal stenosis (LSS) which was the most common indication for spine surgery in older adults (Deyo, et al.,2005;Markman & Gaud, 2008). According to the 2015 statistics of National Health Insurance Administration Ministry of Health and Welfare in Taiwan, low back pain was the 14th illness on the top 20 diseases of 2.1 million citizens and the expenditure of treatment reached to 460 million USD. LSS refers to the narrowing spinal canal with neural compression. The clinical diagnosis of LSS focuses on symptoms, physical examination and imaging findings, medical history, clinical symptoms which range from asymptomatic to severely disable and physical examination results. Radiological observations which are MRI, CT scanning, conventional X-rays and myelography tend to be used most frequently in patient to confirm and differential diagnose LSS(Markman & Gaud, 2008; Siebert et al., 2009; Genevay & Atlas, 2010). Spinal surgery is a constantly and inventive procedure of LSS for decompressing the entrapped neural element and performing lumbar fusion. Current studies revealed that surgery was effective and gained benefits with respect to pain, disability or claudication. However, higher rate of major complication and the cost of LSS related surgeries should be concerned(Fitch et al., 2015). There are some methods of conservative therapies, such as pain medication, epidural injections and rehabilitation to treat the patients with mild to moderate symptoms(Siebert et al., 2009). Few researches revealed that conservative treatment were effective and had success rate up to 70%(Murphy, Hurwitz, Gregory, & Clary, 2006).

Objectives

Researchers in LSS treatment seemed to indicate a lack of consensus and controversy. Treatment planning is an essential issue for physicians to improve medical outcome. In this study, we used data mining technology to find the key factors and rules of treatment issue of conservative treatment and to establish a predictive model for predicting the therapies outcome for LSS to improve the treatment efficiency, patient safety, and avoid unnecessary spine surgeries.

Material and methods

A total of 103 subjects were recruited for collecting medical records from a regional teaching hospital in southern Taiwan. The target patients with LSS came from the orthopedic department, neurology department and rehabilitation department and patients with spondylolisthesis were excluded in this research. The 16 input variables used in this research included patient demography, physician data, physical assessment of LSS, disc prolapse and degenerative disc change observed by MRI data. The output variable was referral to spinal surgery (yes/no). First of all, the logistic regression and C.0 decision tree were applied for feature selection, and then data mining technology of BPNN, SVM, and C.0 decision tree were used afterwards. Finally, the key factors and rules of treatment results of LSS and favorable predictive model were established for predicting the results of conservative treatment. The research flow diagram is shown in Figure 1.

Results and conclusions

As the result, the logistic regression and C.0 decision tree feature selection method found the important factors which were disc height reduction, age, diastolic blood pressure, bone pain and gender. In comparing performance of all predictive models, the logistic regression and decision tree feature selection method combined with Back Propagation neural network model was significantly favorable which the accuracy reached 94.87%, the sensitivity reached 0.9; the specificity reached 1; and AUC reached 0.952(see table 1).

In this study, we identified the important features of treatment outcome and constructed the predictive model that could be an evidence for supporting physicians to make optimal treatment planning in LSS for patients. It would be beneficial to use data mining technology of big data analysis for medical informative system in healthcare industry.

Keywords: lumbar spinal stenosis; conservative therapy; data mining; predict

Table 1. Performance evaluation of predicting models

<table>
<thead>
<tr>
<th>Model established</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined LR,C.0 decision tree and BPNN</td>
<td>0.9</td>
<td>1</td>
<td>94.87</td>
<td>0.952</td>
</tr>
<tr>
<td>BPNN</td>
<td>0.95</td>
<td>0.947</td>
<td>94.87</td>
<td>0.949</td>
</tr>
<tr>
<td>Combined LR,C.0 decision tree and SVM</td>
<td>0.9</td>
<td>0.947</td>
<td>92.30</td>
<td>0.924</td>
</tr>
<tr>
<td>SVM</td>
<td>0.8</td>
<td>1</td>
<td>89.74</td>
<td>0.913</td>
</tr>
<tr>
<td>C.0 decision tree</td>
<td>1</td>
<td>0.8</td>
<td>89.74</td>
<td>0.910</td>
</tr>
</tbody>
</table>