

Analysis of Hospitalization Costs of Non-Surgical Lung Cancer Patients Based on BP Neural Network Model

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Abstract: Objective: The burden of patients with lung cancer is heavy. This study aims to analyze the influencing factors of hospitalization costs. Methods: Descriptive statistics was used to analyze the demographic and disease characteristics and hospitalization cost of patients with lung cancer; single factor analysis was used in the test for non-parametric analysis; BP neural network model was established for multi factor analysis. Results: 1820 cases of lung cancer patients were included in this study. Patients were mostly elderly male patients, and most of them were in clinical stage III and stage IV. The average length of stay was 22.9 days and the mean age was 64.6 years. The media hospital cost was 12501.78 yuan, and medication cost accounted for the largest proportion, with 45.81%. BP neural network model showed that length of stay, medical insurance, admission path, complication, clinical stage, age and gender were the main influencing factors of hospitalization cost. Conclusion: Great importance should be attached to reduce the proportion of drugs and the length of stay, in order to control the hospitalization cost for lung cancer patients.

1. Introduction

The main cause for death has been changed from infectious disease to cancer, and lung cancer is expected to rank as the leading cause of cancer. According to global cancer burden report 2018, there will be 18.1 million new cancer cases, of which 11.6% are lung cancer cases; 9.6 million cases for death, of which 18.4% are lung cancer^[1]. In China, the incidence and death rate of lung cancer are in the first place comparing to other cancers. From 2011 to 2015^[2-6], new cases of lung cancer has been increased from 0.65 million to 0.78 million, and death cases has been increased from 0.53 million to 0.63 million.

The situation of incidence and death for lung cancer is very serious, so the demand of health for lung cancer patients will continue to increase. Compared with other disease, the burden of lung cancer patients is heavier.

The proportion of hospital expense in medical expense is the largest for lung cancer patients. Analyzing hospital expense and exploring the main influencing factors of hospital expense based on BP neural network model, in order to put forward corresponding strategies to control hospitalization expense for health department.

2. Material and Method

2.1 Data Sources

Data of lung cancer patients were selected from a top three hospital between January 2014 and December 2018. Patients whose record without definite diagnosis and with malignant tumor were excluded. Finally, a total of 1820 cases were included. The following data were extracted for each case: demographic characteristics, including gender, age and type of medical insurance. Disease characteristics, including length of stay, clinical stage, admission path and complications. Hospitalization cost, which was classified into seven types, including medication cost, laboratory cost, treatment coat, inspection cost, material cost, bed cost and consultation cost.

2.2 Statistical Analysis

Data recording and statistical analyses were performed with SPSS 23.0. As all data were not normally distributed, all cost results were expressed as median and Interquartile spacing (IQR). The nonparametric test was used for single factor analysis, with $\alpha = 0.05$ as the test standard. P values were two sided and $P < 0.05$ were considered significant. BP model were used for multi factor analysis. Inpatient costs were regarded as dependent variable, demographic and disease characteristics of patients were regarded as independent variables, to construct BP neural network model. According to the importance of each variable, the main influencing factors of hospitalization expenses of non-surgical lung cancer patients were analyzed.

3. Result

3.1 Patient Characteristics

1820 patients were included in the study, the demographic characteristics, which including gender, age, medical insurance, and disease characteristics, including length of stay. Clinical stage, admission path, complications are detailed in Table 2.

The age range for the 1820 patients was 17 to 96 years and mean age was 64.6 years and 59.8% were male. The rang of length of stay was 2 to 98 and mean was 22.9 days. 96.7% lung cancer patients had medical insurance; 20.2% patients were in stage

II, 32.4%

IV, 86.6% patients were outpatients and

3.2 Hospital Costs

Hospital costs are detailed in Table 1. The media hospitalization cost per patients was 12501.78 yuan and the interquartile spacing was 13917.97 yuan. Among the costs, medication cost accounts for the largest proportion, with 45.81% and its media was 5830.67 yuan; treatment costs were in the second place, with 19.74%, its media cost was 1468.65 yuan and laboratory costs were in the third place, with 11.27%, its median cost was 1322.00 yuan.

Table 1 Basic composition of hospitalization expenses for lung cancer patients

Cost	\bar{x}	S	%	M	IQR
Total costs	16140.06	12594.48	100.00	12501.78	13917.97
medication costs	7393.459	7161.303	45.81	5830.67	8479.21
laboratory costs	1819.639	1613.131	11.27	1322.00	1912.25
treatment coats	3185.881	4682.277	19.74	1468.65	3326.30
inspection costs	1733.515	1427.712	10.74	1585.00	2022.75
material costs	1231.908	2746.296	7.63	567.91	1149.53
consultation costs	98.4073	464.5482	0.61	86.50	90.00
bed costs	677.2517	684.9026	4.20	62.00	645.00

3.3 Single Factor Analysis

The result of single factor analysis was shown in Table 2. Hospitalization costs for male were 13429.44 yuan, which was higher than the cost of female ($P < 0.05$). There were differences in costs of lung cancer patients with different ages, the cost of patients was 12489.18 yuan, 13217.49 yuan, 1374.32 yuan, 14011.04 yuan and 12242.42 yuan in patients aged < 45 , 45-54, 55-64, 65-74 and ≥ 75 years old, to some extent, it could be considered as that the older the age, the higher the cost. There were also differences in different medical insurance, length of stay, clinical stage, admission path and complications ($P < 0.05$).

Table 2 Single factor analysis of hospitalization costs of lung cancer patients

	n	%	Media	IQR	Z/H	P
Gender						
Male	1096	59.8	13429.44	14792.09	-2.348	P<0.05
Female	736	40.2	11907.97	13684.24		
Age						
<45	67	3.7	12489.18	14379.48		
45-54	263	14.4	13217.49	14182.57		
55-64	589	32.2	13749.32	18838.43	10.08	P<0.05
65-74	512	27.9	14011.04	15206.29		
≥75	401	21.9	12242.42	12707.84		
Medical insurance						
Yes	1772	96.7	13115.24	14488.82	-3.946	P<0.05
No	60	3.3	9403.57	11251.29		
Length of stay						
<5	141	7.7	3871.24	3886.36		
5-14	634	34.5	8467.21	6312.17	772.434	P<0.05
15-24	430	23.5	14054.10	8545.88		
25-34	242	13.2	19548.22	15359.60		
≥35	387	21.1	26099.84	19895.35		
Clinical stage						
Stage I	175	9.6	8615.83	11076.50		
Stage II	370	20.2	13241.51	16153.09	47.129	P<0.05
Stage III	593	32.4	14893.57	13214.72		
Stage IV	694	37.8	12626.09	14301.84		
Admission path						
outpatient	1587	86.6	12809.74	14363.59	-5.023	P<0.05
emergency	245	13.4	13530.57	14995.27		
Complications						
Yes	903	49.3	14804.49	8598.83	-10.723	P<0.05
No	929	50.7	8162.77	21867.65		

3.4 BP Neural Network Model

Inpatient costs were regarded as dependent variable, demographic and disease characteristics of patients were regarded as independent variables, which were used to build BP neural network model. 70% of the data were randomly selected as the training part and 30% were as the testing part. Using multilayer perceptron neural network model to analyze the importance of each influencing factors.

In BP neural network model, the order of influencing factors of hospitalization expenses was length of stay (0.410), medical insurance (0.187), admission path (0.146), complication (0.111), clinical stage (0.068), age (0.054) and gender (0.025), which has been shown in Table 3 and Fig.1.

Table 3 Importance and ranking of influencing factors of BP neural network model

Variation	Importance	Importance of standardization	Order
Length of stay	0.410	100.0%	1
Medical insurance	0.187	45.5%	2
Admission path	0.146	35.5%	3
Complication	0.111	27.0%	4
Clinical stage	0.068	16.5%	5
Age	0.054	13.2%	6

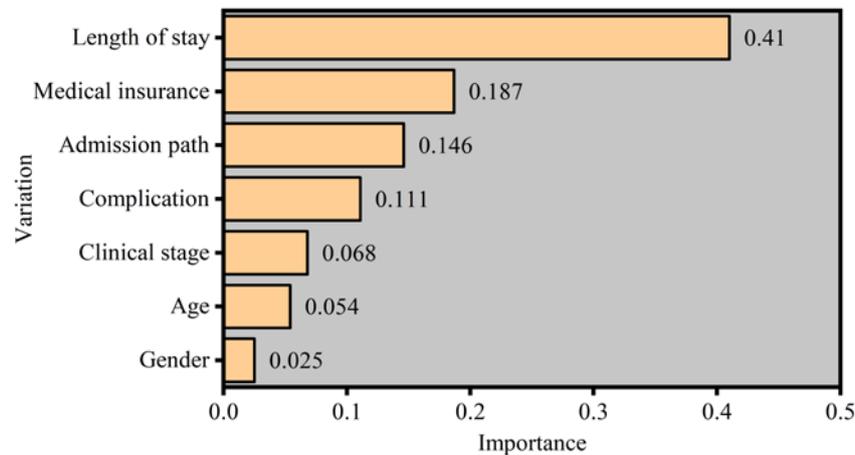


Fig. 1 The importance ranking of influencing factors in BP neural network model

4. Discussion

This paper reviews that medical cost was main component of hospitalization cost, accounting for 45.81%. Therefore, it is of great significance for hospitalization cost to control the medication cost. Relevant researches have shown that after cancelling drug price addition, the proportion of medication cost will reduce and the hospitalization cost could be controlled to a certain extent [7, 8]. Besides, the treatment cost, laboratory cost and inspection cost were also the main component of hospitalization cost, which were the items that need to be controlled in addition to medication cost. Recently, with the common use of high-tech disposable consumables, material costs have increased significantly.

BP neural network model showed that the most influential factor for hospitalization cost was the length of stay. Patients with hospitalization days ≥ 35 had the highest hospitalization cost. The longer the length of stay, the more treatment the patients will receive, so that the higher the hospitalization cost would be. In addition, medical insurance was the second influence factor, the hospitalization cost of patients with medical insurance was higher than that of patients without. The hospitalization cost of patients admitted through emergency department was higher than that of patients admitted through outpatient department. Lung cancer patients with complications cost more. In the treatment process by complications, the treatment will be more difficult, the impact of complications on the overall treatment should be considered.

Clinical stage was also an important factor of hospitalization cost, cost of patients in clinical stage ~~all was the highest~~ ^{III was the highest}. The more difficult the treatment would be. The hospitalization cost of lung cancer patients aged 45-54, 55-64 and 65-74 was the highest; the hospitalization cost of patients aged ≥ 75 years was the lowest. The possible reason is that 45-74 year olds are better than the elderly in terms of economic ability and physical quality, and they will choose better medical scheme and active treatment. However, the prognosis of the elderly is poor compared with the young patients, and they will be relatively conservative in the selection of treatment methods, and the cost of hospitalization is relatively low.

5. Conclusion

BP neural network model is suitable for the analysis of influencing factors of hospitalization expenses. It is suggested that it is a wise option to optimize the internal structure of hospitalization expenses while reducing the proportion of medication cost [9]. At the same time, standardizing the process of diagnosis and improving the efficiency of treatment, so as to shorten the clinical length of stay [10]. The coverage and compensation level of medical insurance should be improved further.

Finally, the early diagnosis and treatment of lung cancer and the health awareness of residents should be strengthened, so as to reduce the incidence of lung cancer and the economic burden of lung cancer patients from the source.

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