Research Square

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# Braden Scale for Assessing Pneumonia After Acute Ischemic Stroke

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# Abstract

Background Prevention of pneumonia is critical for patients with acute ischemic stroke (AIS). The six indexes in the Braden Scale seemsto be related to the occurrence of pneumonia. We aimed to evaluate the feasibility of the Braden Scale in predicting the occurrence of pneumonia after AIS. Methods We studied a series of consecutive patients with AIS who were admitted to hospital. The cohort was subdivided into pneumonia group and no pneumonia group. The score of the Braden Scale, demographic and clinical characteristics at admission were obtained and analyzed by statistical comparisons between two groups. We investigated the predictive validity of the Braden scale by Receiver operating curve (ROC). Results 414 patients with AIS were included in this study. 57 of 414 (13.8%) patients fulfilled the criteria for post-stroke pneumonia. The National Institutes of Health Stroke Scale (NIHSS) score in the pneumonia group was significantly higher than in the no pneumonia group ($P < 0.01$). The mean score of the Braden Scale in the pneumonia group was significantly lower than that in the no pneumonia group ($P < 0.01$). The six subscales of the Braden Scale between the two groups all had significant differences. The area under the curve (AUC) for the Braden scale predicting pneumonia after acute ischemic was 0.883 (95% CI = 0.828-0.937). And with 18 points as the demarcation score, the sensitivity was 83.2% and the specificity was 84.2%. Conclusion The Braden Scale with 18 points as the demarcation score is a valid clinical grading scale for predicting pneumonia after AIS at presentation. Further studies on effect of Braden Scale on stroke outcomes are needed.


# Background

Currently, ischemic stroke is one of the most important causes of death and disability in China, which results in a huge social and economic burden[1]. Pneumonia is a common medical complication after acute ischemic stroke (AIS)[2, 3], with longer length of stay, higher risk of mortality and morbidity[4]. Compared to the treatment of pneumonia, effective prevention is more critical. Factors that have been associated with pneumonia after AIS include: older age, dysarthria/aphasia, cognitive impairment, stroke severity, long-term bedridden, dysphagia, decreased body resistance, and so on[5, 6]. We hope to find an effective scale to predict the risk of pneumonia in patients with AIS according to these risk factors.

The Braden Scale is one method used to determine a patient's risk for developing a pressure ulcer, which uses six different risk factors: sensory perception, the ability to respond meaningfully to pressure-related discomfort; skin moisture, degree to which skin is exposed to moisture; activity, degree of physical activity; mobility, ability to change and control body position; nutrition, usual food intake pattern; and friction and shear[7]. These indexes in the Braden Scale seem to be related to the occurrence of pneumonia. In this paper, we retrospectively analyzed the correlation between the Braden Scale and the pneumonia after AIS included in the stroke center of our hospital, to evaluate the feasibility of the Braden Scale in predicting the occurrence of pneumonia after AIS.

# Methods

### Study participants

This retrospective study included AIS patients who were admitted to the stroke center of our hospital between December 2015 and December 2018. The diagnosis of AIS was according to World Health Organization criteria[8] and confirmed by head computerized tomography or brain MRI. This study excluded patients with transient ischemic attacks or subarachnoid hemorrhage. Pneumonia after AIS was diagnosed according to the Centers for Disease Control and Prevention criteria[9] for hospital-acquired pneumonia, on a basis of clinical and laboratory indices of respiratory tract infection (fever, roductive cough with purulent sputum, auscultatory respiratory crackles, bronchial breathing, or positive sputum culture), and supported by abnormal chest radiographic findings. Only hospital-acquired pneumonia was included and pneumonia before stroke was not considered.

### Data collection

Demographic and clinical characteristics were obtained including demographic data (age and sex), associated vascular risk factors (hypertension, hyperlipidemia, diabetes, past stroke or transient ischemic attack history, history of smoking and drinking), physical examination (systolic blood pressure, diastolic blood pressure), laboratory examination (total cholesterol, triglyceride, low density lipoprotein cholesterol, high density lipoprotein cholesterol, fasting blood glucose, glycosylated hemoglobin, serum creatinine), etiological classification of ischemic stroke (large atherosclerotic stroke, arteriolar occlusive stroke, cardiogenic cerebral embolism, other stroke with definite etiology, stroke of unknown etiology) and the National Institutes of Health Stroke Scale (NIHSS) score.

The Braden scale measured at admission is composed of six subscales: sensory perception, skin moisture, activity, mobility, nutrition, and friction and shear. The minimum score for each item is 1 (worst) and the maximum score is 4 (best), except for the score in friction and shear, which ranges from 1 to 3. The sum scores range from 6 to 23, with lower scores associated with higher risk.[10]

### Statistical analysis

Statistical comparisons were made for pneumonia versus no pneumonia after AIS. For normally distributed continuous variables (described as mean and SD), analysis was made by unpaired Student's *t* test. For nonnormally distributed continuous variables, analysis was made by the Mann-Whitney *U* test. Categorical variables were analyzed by the chi-square test or *Fisher* test. Statistical analysis was performed using the SPSS version 20 (SPSS Inc., Chicago, IL, USA). A *P*-value < 0.05 was considered statistically significant. Then, we investigated the predictive validity of the Braden scale to pneumonia after AIS by Receiver operating curve (ROC). The area under the curve (AUC) of 0.97–1.00 are identified as excellent accuracy; 0.93 to 0.96 as very good; 0.75 to 0.92 as good; but an AUC < 0.75 has obvious deficiencies, and AUC of 0.5 indicates that the test has no predictive ability[11].

## Results

### Subject characteristics

525 patients with AIS were admitted to the stroke center of our hospital between December 2015 and December 2018. Among them, 56 cases were discharged from hospital within 2 days, 55 cases were incomplete or missing data. At last, 414 patients with AIS were included in this study. 57 of 414 (13.8%) patients fulfilled the criteria for hospital-acquired pneumonia, and 357 (86.2%) had no pneumonia. The study population had a mean age of 71.5 years, and ranged from 50 to 89 year. Almost 63.8% patients (264) were men, and 36.2% patients (150) were women.

### Correlation of demographic and clinical characteristics between two groups

The demographic data (sex), associated vascular risk factors (hypertension, hyperlipidemia, diabetes, past stroke or transient ischemic attack history, history of smoking and drinking), physical examination (systolic blood pressure, diastolic blood pressure), laboratory examination (total cholesterol, triglyceride, low density lipoprotein cholesterol, high density lipoprotein cholesterol, fasting blood glucose, glycosylated hemoglobin, serum creatinine), between pneumonia versus no pneumonia had no significant difference. There were significant differences in age between the two groups. A significant difference also emerged between the two groups for NIHSS score, which was significantly higher in the pneumonia group than in the no pneumonia group (13.6 ±5.0 vs 9.2 ±3.6, $P < 0.01$). (Table 1)

The mean score of the Braden Scale in the pneumonia group was 15.263 ± 2.579, which was significantly lower than that in the no pneumonia group (19.546 ±2.265, $P < 0.05$).(Table 1) The six subscales of the Braden Scale between the two groups all had significant differences. (Table 2)

### The validity between Braden scale /NIHSS score and pneumonia after acute ischemic

The AUC for the Braden scale predicting pneumonia after acute ischemic was 0.883 (95% CI = 0.828-0.937). And with 18 points as the demarcation score, the sensitivity was 83.2% and the specificity was 84.2%. It was suggested that the incidence of pneumonia in patients with AIS can be predicted by 18 points of the Braden scale, with a sensitivity of 83.2% and a specificity of 84.2%. (Fig. 1)

The AUC for NIHSS score predicting pneumonia after acute ischemic was 0.767 (95% CI = 0.697-0.837). And with 12 points as the demarcation score, the sensitivity was 73.7% and the specificity was 73.1%. (Fig. 2)

# Discussion

The primary objective of the present study was to find an effective and simple scale to identify patients at high risk of pneumonia after AIS. It was the first study to evaluate the feasibility of the Braden Scale in predicting the occurrence of pneumonia after AIS. In this study, we explored a comprehensive range of demographic and clinical characteristics associated with post-stoke pneumonia. We found that the stroke classification, the NIHSS score and the score of the Braden Scale, especially the six subscales of the Braden Scale between the pneumonia and no pneumonia groups had significant differences.

In this study, pneumonia was found in 13.8% of patients presenting with an AIS, which was similar to the incidence of prior studies ranging from 5% to 26%[12-15]. The post-stoke pneumonia was associated with lower early and long-term survival, longer hospitalization, and higher disability at discharge[4]. So it was very important to prevent post-stoke pneumonia. However, a systematic review on efficacy of early antibiotics prophylaxis after stroke failed to show benefit in patients' outcome[16]. This might be attributable to inclusion of patients with low risk of developing post-stoke pneumonia in these studies. It was critical to find an effective scale to predict the occurrence of pneumonia in patients after AIS, and to intervene in high risk patients to prevent pneumonia and improve the outcome of patients. The Braden scale was composed of six subscales: sensory perception, skin moisture, activity, mobility, nutrition, and friction and shear, which seemed to be related to the occurrence of pneumonia. In this study, we found that the mean score of the Braden Scale in the pneumonia group was significantly lower than that in the no pneumonia group, and the six subscales of the Braden Scale between the two groups had significant differences. And, the AUC for the Braden scale predicting post-stoke pneumonia was 0.883, which was identified as good accuracy, as shown above. With 18 points as the demarcation score, the sensitivity and the specificity was high.

We also found that the NIHSS score in the pneumonia group was significantly higher than the no pneumonia group. The NIHSS score has been found to be an independent predictor of pneumonia in some prior prediction models[14, 17-19]. The occurrence of pneumonia in patients with a higher NIHSS score may be due to the decreased consciousness or to gastroesophageal reflux because of a supine or recumbent position. This result also suggested that the pneumonia group had a higher neurological deficit. Previous studies had confirmed that patients with cardiogenic embolism tended to have more neurological deficits[20], and our study supported this conclusion that patients with cardiogenic embolism are more likely to be complicated with pneumonia. However, the Braden Scale had a greater advantage in quantifying risk factors and evaluating the incidence of post-stoke pneumonia.

Several post-stoke pneumonia prediction rules have been developed; however, these models have not been widely used in clinical practice. It is not our intention to show superiority of the the Braden Scale in predicting the occurrence of post-stoke pneumonia compared to the earlier scores; however, we want to point out the difference. Kwon et al[17] developed a pneumonia score, including age, sex, mechanical ventilation, NIHSS score, and dysphagia. However, the study was not validated externally and was limited by small sample size. Sellars et al[6] presented several key predictors for post-stroke pneumonia, including older age, dysarthria, low abbreviated mental test score, modified Rankin Scale score >4, and failed water swallowing test. Although the model was informative, some useful predictors were not routinely collected. Chumbler et al[21] presented a three-level scoring system for predicting post-stroke pneumonia, including medical history of pneumonia, increasing NIHSS score, dysphagia, being found down at symptom onset, and older age. Although the model showed acceptable C-statistics, the study was limited by its lacking of validation and retrospective nature.

Our study had some limitations that deserve comment. First, as all observational studies, we cannot rule out the possibility that additional baseline variable (unmeasured confounders) might have some impact

on the development of post-stroke pneumonia, such as use of angiotensin receptor blockers or angiotensin-converting enzyme inhibitors[22]. Second, the time course of post-stroke pneumonia was unclear. Because we only have information on new-onset post-stroke pneumonia during hospitalization without documentation of the exact date, our data allowed no conclusion as to whether patients with a longer length of stay were more likely to develop pneumonia or whether diagnosis of pneumonia leaded to a longer hospitalization. Third, the study included only hospitalized patients with AIS, and those patients died shortly after admission, in the emergency department, or treated in outpatient clinics were not included. Fourth, our study was from a single center with limited patients. Finally, the Braden Scale used for predicting the occurrence of post-stoke pneumonia need to be further validated in additional populations.

# Conclusions

In summary, the Braden Scale with 18 points as the demarcation score is a valid clinical grading scale for predicting pneumonia after AIS at presentation. Further studies on effect of Braden Scale on stroke outcomes are needed.

# Abbreviations

AIS: Acute Ischemic Stroke; ROC: Receiver Operating Curve; NIHSS: National Institutes of Health Stroke Scale; AUC: Area Under the Curve; TIA, transient ischemic attack.

# Declarations

### Ethics approval and consent to participate

The study was approved by the medical ethics committee of Jingjiang People's Hospital. Written informed consent was obtained from all participants and their informants.

### Consent for publication

Not applicable.

### Availability of data and material

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

None of the authors report a conflict of interest.

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### Authors' contributions

Study concept and design: YL, PT and YLD. Data analysis: YZY and JLN. Data collection: all. Writing the manuscript: YLD, YZY and JLN.

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Not applicable.

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# Tables

**Table 1. Demographic and clinical characteristics between two groups.**

| | No pneumonia (n=357) | Pneumonia (n=57) | *P* value |
|---|---|---|---|
| Age/year | 71.0±8.9 | 74.7±7.5 | 0.001 |
| Male(case, %) | 225(63.0) | 39(68.4) | 0.462 |
| Smoking status(case, %) | 140(39.2) | 28(49.1) | 0.191 |
| Drinking status(case, %) | 147(27.4) | 22(38.6) | 0.773 |
| Hypertension(case, %) | 195(54.6) | 34(59.6) | 0.642 |
| Hyperlipidemia(case, %) | 101(28.3) | 12(21.1) | 0.336 |
| Diabetes(case, %) | 96(26.9) | 18(31.6) | 0.523 |
| Stroke/TIA (case, %) | 36(10.1) | 5(8.8) | 1.000 |
| Fasting blood glucose (mmol/L) | 5.9±1.6 | 5.8±0.76 | 0.255 |
| Glycosylated hemoglobin (%) | 5.8±0.7 | 5.8±0.7 | 0.822 |
| Serum creatinine (umol/L) | 80.4±20.6 | 82.0±25.1 | 0.595 |
| Systolic blood pressure (mmHg) | 145.5±17.7 | 143.1±17.4 | 0.342 |
| Diastolic blood pressure (mmHg) | 87.3±10.9 | 89.4±10.0 | 0.189 |
| Total cholesterol (mmol/L) | 5.0±1.2 | 5.2±1.6 | 0.329 |
| Triglyceride (mmol/L) | 1.5±0.8 | 1.4±0.5 | 0.594 |
| Low density lipoprotein cholesterol (mmol/L) | 3.1±0.8 | 3.1±0.8 | 0.955 |
| High density lipoprotein cholesterol (mmol/L) | 1.2±0.5 | 1.2±0.4 | 0.571 |
| Stroke classification | | | |
| Large atherosclerotic stroke(case, %) | 140(39.2) | 26(45.6) | 0.384 |
| Arteriolar occlusive stroke(case, %) | 90(25.2) | 19(33.3) | 0.199 |
| Cardiogenic cerebral embolism(case, %) | 49(13.7) | 3(5.3) | 0.085 |
| Other stroke with definite etiology(case, %) | 34(10.0) | 3(5.3) | 0.452 |
| Stroke of unknown etiology(case, %) | 44(12.3) | 6(10.5) | 0.829 |
| NIHSS score | 9.2±3.6 | 13.6±5.0 | 0.000 |
| Braden scale | 19.6±2.3 | 15.3±2.5 | 0.000 |

The NIHSS score in the pneumonia group was significantly higher than that in the no pneumonia group. The mean score of the Braden Scale in the pneumonia group was significantly lower than that in the no pneumonia group.

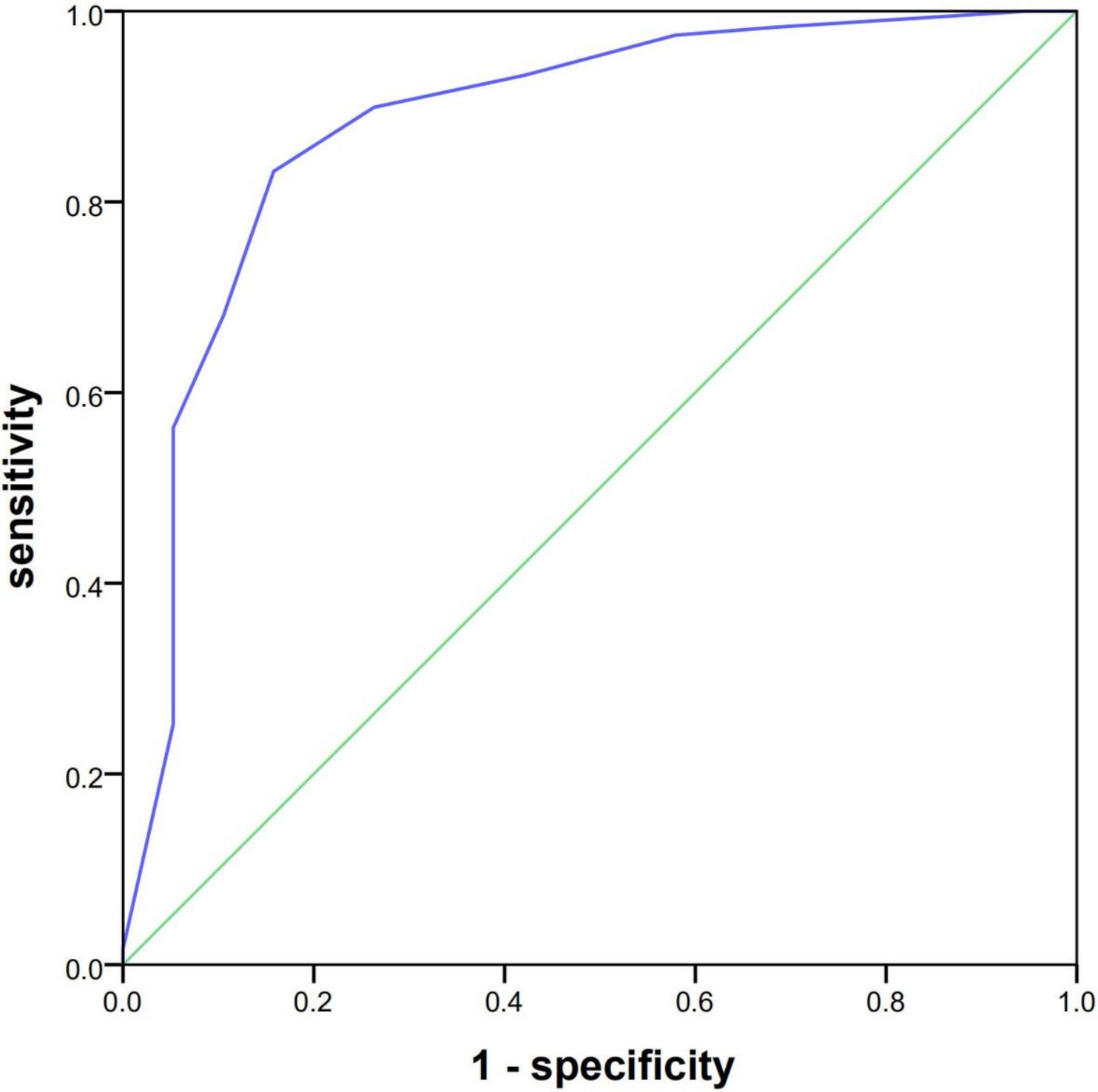
TIA, transient ischemic attack; NIHSS, National Institutes of Health Stroke Scale.

**Table 2. The Braden scale between two groups (mean±SD).**

| Braden scale | No pneumonia (n=357) | Pneumonia (n=57) | *P* value |
|---|---|---|---|
| Sensory perception | 3.7±0.5 | 2.8±0.7 | 0.000 |
| Skin moisture | 4.0±0.2 | 3.7±0.6 | 0.000 |
| Activity | 3.0±1.0 | 1.6±1.0 | 0.000 |
| Mobility | 3.5±0.6 | 2.5±0.6 | 0.000 |
| Nutrition | 3.0±0.3 | 2.8±0.4 | 0.001 |
| Friction and shear | 2.4±0.6 | 1.9±0.5 | 0.000 |
| Sum score | 19.6±2.3 | 15.3±2.5 | 0.000 |

The six subscales of the Braden Scale between the two groups all had significant differences.

# Figures




## Figure 1

ROC curve of the Braden scale. The AUC for the Braden scale predicting pneumonia after acute ischemic was 0.883 (95% CI = 0.828-0.937). And with 18 points as the demarcation score, the sensitivity was 83.2% and the specificity was 84.2%.

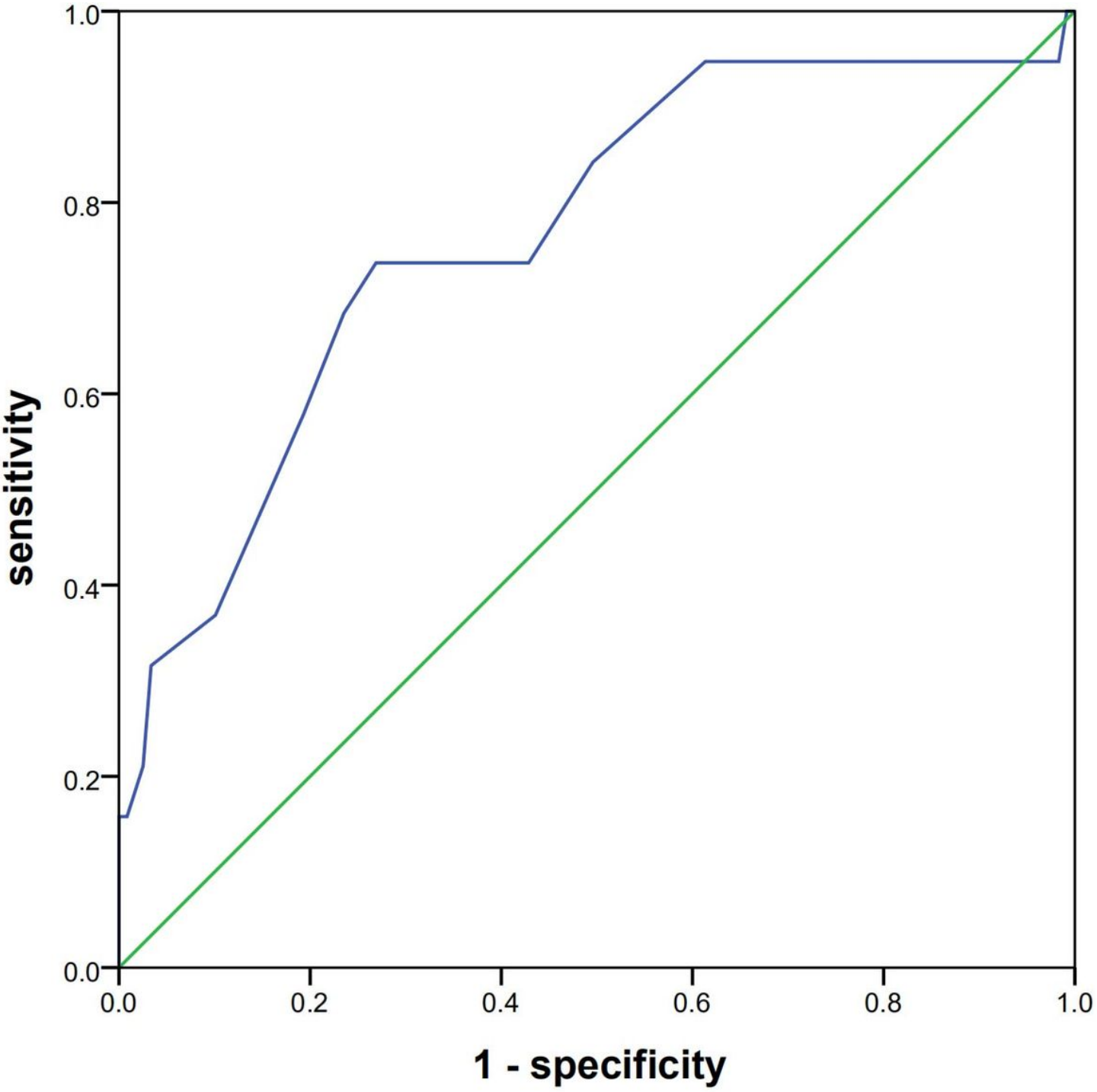



**Figure 2**

ROC curve of the NIHSS score. The AUC for NIHSS score predicting pneumonia after acute ischemic was 0.767 (95% CI = 0.697-0.837). And with 12 points as the demarcation score, the sensitivity was 73.7% and the specificity was 73.1%.

# Supplementary Files

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