News Release

Title

A diagnostic predictive model of bronchoscopy with radial endobronchial ultrasound for peripheral pulmonary lesions ～ Development of implementable model made from high volume center～

Key Points

- We made up a diagnostic predictive model of bronchoscopy with radial endobronchial ultrasound based only on factors before bronchoscopy.
- The predictive model was made up from expert center performed over 1,000 cases of bronchoscopy per year.
- The predictive model might enable patients to select diagnostic methods other than bronchoscopy if the predicted diagnostic yield of peripheral pulmonary lesions was low.

Summary 1

Assistant Professor **Takayasu Ito**, Assistant Professor **Shotaro Okachi**, Associate Professor **Naozumi Hashimoto**, and Professor **Makoto Ishii** in the department of respiratory medicine, Nagoya University Graduate School of Medicine), **Yuji Matsumoto** in the department of Endoscopy, Respiratory Endoscopy Division, National Cancer Center Hospital and department of Thoracic Oncology, National Cancer Center Hospital, and Assistant Professor **Kazuki Nishida** in the department of Biostatistics, Nagoya University Graduate School of Medicine made up a diagnostic predictive mode of bronchoscopy with radial endobronchial ultrasound based only on factors before bronchoscopy.

The bronchoscopy with radial endobronchial ultrasound (R-EBUS) have been widespread for the diagnosis of peripheral pulmonary lesions (PPLs). However, there is no predictive model that combines them to estimate the diagnostic yield. Therefore, it is difficult for physicians to accurately predict in advance the diagnostic potential of bronchoscopy for each PPL. We analysed a total of 1,634 lesions which performed bronchoscopy with R-EBUS. Previous studies reported that the probe position relative to the lesions during bronchoscopy was a significant predictive factor for successful bronchoscopic diagnosis with R-EBUS. When the probe is located within, the diagnostic yield has been reported to be approximately

90%. Therefore, biopsies should be performed from a position within the lesion as much as possible. However, it has the problem of providing the diagnostic yield to patients with PPLs unless they undergo bronchoscopy. the present predictive model using the seven factors revealed a good performance in estimating the diagnostic yield of bronchoscopy with R-EBUS for PPLs. This model might assist physicians and patients to choose a preferable diagnostic method for each PPL. This research was published in the journal of Respiration (November 4, 2022).

Summary 2

Research Background

The diagnostic yield of PPLs using conventional bronchoscopy ranges from 30% to 60%. However, the yield has improved to 70%–80% after the introduction of advanced bronchoscopy with radial endobronchial ultrasound (R-EBUS) and a navigation system. Previous studies reported that the probe position relative to the lesions during bronchoscopy was a significant predictive factor for successful bronchoscopic diagnosis with R-EBUS. When the probe is located within, adjacent to, or outside the lesion, the diagnostic yields have been reported to be approximately 90%, 42%, and 18%, respectively. Therefore, biopsies should be performed from a position within the lesion as much as possible.

With respect to the factors obtained prior to bronchoscopy, the bronchus sign, which represents the detection of a bronchus directly leading to the lesion on CT, lesion size have been reported to significantly affect the diagnostic yield of bronchoscopy with R-EBUS for PPLs. Although these factors influence the success of bronchoscopic diagnosis, there is no predictive model that combines them to estimate the diagnostic yield. Therefore, it is difficult for physicians to accurately predict in advance the diagnostic potential of bronchoscopy for each PPL. If presented with a high yield, patients will probably choose bronchoscopy, but conversely, if presented with a low yield, patients may prefer other diagnostic methods such as TTNB or SLB, while weighing the safety advantages of bronchoscopy.

Research Results

We retrospectively analysed a total of 1,634 lesions between April 2012 and October 2015. The predictive model for the diagnostic yield was generated by the following methods. First, from a well-known clinical perspective, two explanatory variable candidates, bronchus sign and lesion size, were forced into the logistic regression model. The remaining explanatory variable candidates were selected appropriately to minimize the Akaike information criterion (AIC) of the logistic regression model among sex, lesion lobe, lesion location from the hilum, lesion structure, visibility on chest X-ray, and background lung. Finally, the predictive model consisted of seven factors: lesion size, lesion lobe, lesion location from the hilum, lesion structure, bronchus sign, visibility on chest X-ray, and background lung. The ROC AUC of the predictive model was 0.742 (95% confidence interval: 0.715–0.769). Internal validation using 10-fold stratified cross-validation revealed a mean ROC AUC of 0.734.

To create the integer-based scoring system for clinical practice, the coefficient of each variable was calculated as a simple integer ratio from the logistic model selected above, based on the coefficient for a 1-mm change in lesion size. The coefficients of each variable are listed in Figure 1a, while the relations between the integer-based scores and predictive diagnostic yields are presented in Figure 1b. One example of the score and the corresponding predictive diagnostic yield was presented in Figure 2. The total score (Integer-Based score) and the predictive diagnostic yield were 286 and about 90%, respectively.

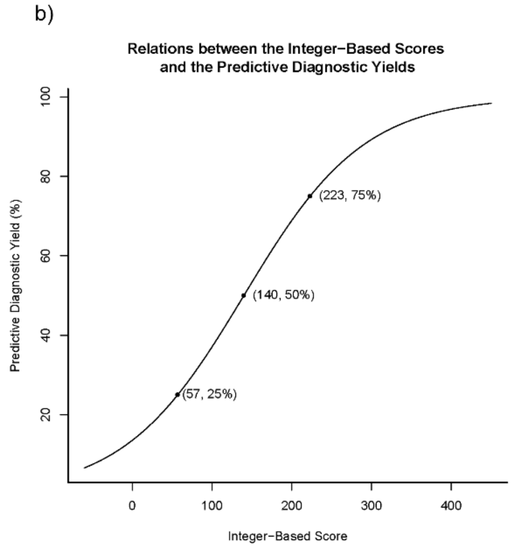
Figure 1

a)

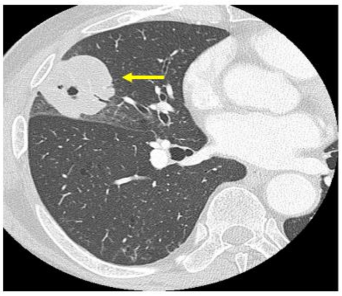
Score	Parameter (X)	
1 (α_1)	X_1	Lesion size, mm
20 (α_2)	X_2	0 if lesion is located in right upper lobe/left upper segment 1 if lesion is located in middle lobe/lingula 0 if lesion is located in right lower lobe/left lower lobe
20 (α_3)	X_3	0 if lesion location from the hilum is outer 1 if lesion location from the hilum is inner
35 (α_4)	X_4	0 if lesion structure is subsolid 1 if lesion structure is solid
100 (α_5)	X_5	0 if bronchus sign is negative 1 if bronchus sign is positive
85 (α_6)	X_6	0 if lesion on chest X-ray is invisible 1 if lesion on chest X-ray is visible
− 45 (α_7)	X_7	0 if interstitial lung abnormalities are absent as background lung 1 if interstitial lung abnormalities are present as background lung

Total score ＝ α1 × X1 + α2 × X2 + · · · · + α7 × X7

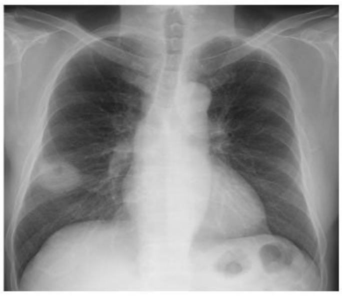
b)



a)



b)



c)

Score	Parameter (X)		Score ×Parameter
1 (α_1)	46.0 (X_1)	Lesion size, mm	46
20 (α_2)	Right middle lobe (X_2)	0 if lesion is located in right upper lobe/left upper segment 1 if lesion is located in middle lobe/lingula 0 if lesion is located in right lower lobe/left lower lobe	20
20 (α_3)	Outer (X_3)	0 if lesion location from the hilum is outer 1 if lesion location from the hilum is inner	0
35 (α_4)	Solid (X_4)	0 if lesion structure is subsolid 1 if lesion structure is solid	35
100 (α_5)	Positive (X_5)	0 if bronchus sign is negative 1 if bronchus sign is positive	100
85 (α_6)	Visible (X_6)	0 if lesion on chest X-ray is invisible 1 if lesion on chest X-ray is visible	85
− 45 (α_7)	Absent (X_7)	0 if interstitial lung abnormalities are absent as background lung 1 if interstitial lung abnormalities are present as background lung	0

Total score

$= \alpha1 \times X1 + \alpha2 \times X2 + \cdot\cdot\cdot + \alpha7 \times X7$

$= 1 \times 46.0 + 20 \times 1 + 20 \times 0 + 35 \times 1 + 100 \times 1 + 85 \times 1 + (-45) \times 0$

$= 286$

Predictive diagnostic yield ＝ 87.4%

Research Summary and Future Perspective

We are planning to develop multicenter research and propose our result to the Japan Society for Respiratory Endoscopy and the Japanese Respiratory Society and launch it to make a guideline for bronchoscopy. We expect that building predictive model as an application will make it easier to use for physicians other than respiratory physicians.

Technical Terms

Bronchoscope: The device with a thin and soft tube with a diameter of about 3-6mm to investigate the trachea and bronchi leading to the lungs deep in the chest.

Bronchus sign: The sign represents he detection of a bronchus directly leading to the lesion on CT

Akaike information criterion (AIC): AIC is mathematical method for evaluating how well a model fits the data it was generated from. If AIC was lower, the model was better model.

Logistic analysis: The appropriate regression analysis to conduct when the dependent variable is dichotomous (binary).

Scaling: It was the procedure of measuring and assigning the objects to the numbers based on the specified rules.

Publication

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