

Bronchiectasis severity assessment on predicting hospital readmission: a single-center prospective cohort study

Xiao-Yue Wang¹, Ru Li², Wan-Ying Wang¹, De-Shuai Li³, Yu-Yan Zhou¹, Xiao-Ting Chen¹, Xiao-Ning Bu¹

¹Department of Respiratory and Critical Care Medicine, Beijing Institute of Respiratory Diseases, Chaoyang Hospital, Capital Medical University, Beijing 100020, China;

²Ciqu Health Center of Tongzhou District, Beijing 101111, China;

³Department of Respiratory Medicine, Beijing Renhe Hospital, Beijing 102600, China.

To the Editor: Bronchiectasis is a chronic respiratory disorder characterized by recurrent cough, sputum production, and respiratory infections. Management of bronchiectasis has got an increased emphasis in recent years.^[1] Patients with bronchiectasis should undergo routine monitoring in order to identify disease progression and modify treatment when necessary. In recent years, three composite disease-specific systems have been developed, which are verified for evaluating bronchiectasis severity and predicting prognosis: bronchiectasis severity index (BSI), FAGED (F: forced expiratory volume in 1 s % predicted [FEV1%pred], A: age, C: presence of chronic colonisation by *Pseudomonas aeruginosa*, E: radiological extension [number of pulmonary lobes affected], D: dyspnoea) and FAGED plus exacerbations in the previous year (E-FAGED).^[2-4] All three scoring systems classify patients into low, moderate, and high risk groups by different thresholds, respectively. Study shows that BSI can better predict mortality, exacerbations, quality of life, respiratory symptoms, 6-min walk distance, and lung function decline in bronchiectasis. Updated in 2019, British Thoracic Society (BTS) guideline for bronchiectasis in adults emphasizes that the use of BSI and FAGED scoring systems has increased ability to predict future mortality in patients with bronchiectasis, as well as assisting in guiding the disease management.^[4] However, literature about these systems in predicting hospital readmission in patients with bronchiectasis is still limited. This study evaluated the prediction ability of BSI, FAGED, and E-FAGED on assessing the readmission risk of bronchiectasis patients, as well as making comparison of the prediction ability among the three systems.

We consecutively enrolled patients with bronchiectasis admitted to the Beijing Chaoyang Hospital between April and November in 2017 as our subjects and followed up for 12 months since their discharge. All participants or

guardians gave written informed consent and the study was approved by Ethics Committee of Beijing Chaoyang Hospital Affiliated to Capital Medical University (No. 2017-SCI-92). The diagnosis of bronchiectasis was defined according to the BTS guideline,^[5] namely, at least one of the three features are suggested on high resolution computerized tomography: bronchoarterial ratio >1 (internal airway lumen *vs.* adjacent pulmonary artery); lack of tapering of the bronchial lumen toward the periphery; Airway visibility within 1 cm of costal pleural surface or touching mediastinal pleura. Patients were excluded if they were (1) under 14 years old; (2) with malignant tumors, cystic fibrosis, active pulmonary tuberculosis, immune system disorders, pulmonary fibrosis; (3) unable to complete the follow-up.

An exacerbation was defined as the requirement for antibiotics in the presence with an acute deterioration (usually over several days) with worsening respiratory symptoms (cough, increased sputum volume or change of viscosity, increased sputum purulence with or without increasing wheeze, breathlessness, hemoptysis) and/or systemic upset.^[4]

Baseline data of patients have been collected about anthropometry, clinical symptoms, hospitalization and exacerbation frequency, radiographic manifestations, lung function, bacterial colonization, and other information required in the three symptoms.

Follow-up data has been obtained via telephone or face-to-face interviews every 2 months for 1 year. In that period, we recorded outcomes of the disease, frequency of hospital admissions due to bronchiectasis exacerbation.

Statistical analysis process was performed by SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) and R version

Access this article online

Quick Response Code:



Website:

www.cmj.org

DOI:

10.1097/CM9.0000000000001051

Correspondence to: Dr. Xiao-Ning Bu, Department of Respiratory and Critical Care Medicine, Beijing Chaoyang Hospital, Capital Medical University, 8 Gongti Nanlu, Chaoyang District, Beijing 100020, China
E-Mail: 13641000837@163.com

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Chinese Medical Journal 2021;134(4)

Received: 26-02-2020 Edited by: Li-Shao Guo

3.4.3. Quantitative data are expressed as mean \pm standard deviation or median (interquartile range) while qualitative variables are expressed as numbers and percentages. The correlation of categorical data was tested by Chi-square test and Fisher test. Rank sum test was employed to evaluate the correlation of ranked data. Receiver operating characteristic (ROC) curve was used to evaluate the predictive power of the three scoring systems for readmission risk, with DeLong test being adopted to compare the difference of areas under ROC curves (AUC) of the three scoring tools and the difference of the AUCs in different sub-groups by age and gender. Significance level was 0.05. The Bonferroni method was used for multiple comparison adjustment.

As a result, a total of 168 patients with bronchiectasis have been recruited at baseline, with 20 of them refusal to participate or loss to follow-up; thus, the dropout rate was 11.9%. Baseline data of the 148 subjects are shown in Table 1. More than one-third (37.8%) of patients with bronchiectasis were re-hospitalized due to exacerbation, with the median duration of 115.5 days.

Variable values in readmission group were at a significant higher level than in non-readmission group including male proportion, age, cough proportion, sputum proportion, course of disease, modified Medical Research Council

score, lobes affected, number of exacerbations, and hospitalizations in the prior year. Whilst forced expiratory volume in 1 s %pred and body mass index in readmission group were significantly lower than in non-readmission group. And *Pseudomonas aeruginosa* (*P. aeruginosa*) colonization and other bacteria colonization were respectively found in 10.7% and 10.7% in the readmission patients, while 4.3% and 2.2% in the non-readmission patients. Although there was no significant difference between the two groups ($P = 0.139$), it may suggest a potential trend.

Areas under ROC curves of the three scores were as follows: for BSI 0.857, FACED 0.760, and E-FACED 0.811 [Supplementary Figure 1, <http://links.lww.com/CM9/A287> and Supplementary Table 1, <http://links.lww.com/CM9/A287>]. Combined with Delong test and adjusted with Bonferroni, BSI was relatively the most effective system, followed by E-FACED score [Supplementary Table 2, <http://links.lww.com/CM9/A287>].

We carried out a sub-group analysis based on age. Numerically, the AUCs of the three scores increased with age, but there was no significant difference in ROC curves of different age groups using DeLong test [Supplementary Tables 3, <http://links.lww.com/CM9/A287> and 4, <http://links.lww.com/CM9/A287>]. Another sub-group was layered by gender, also numerically, the male group had

Table 1: Baseline demographics, clinical characteristics, and scores by three systems between non-readmission and readmission group.

Variables	Whole group (n = 148)	Non-readmission (n = 92)	Readmission (n = 56)	Statistical value	P value
Male	55 (37.2)	27 (29.3)	28 (50.0)	$\chi^2 = 6.358$	0.011
Age (years)	61.3 \pm 9.9	60.2 \pm 9.8	63.1 \pm 9.9	$Z = 2.030$	0.042
BMI (kg/m ²)	22.9 \pm 4.1	23.6 \pm 3.2	21.8 \pm 5.2	$Z = -2.395$	0.016
Smoking	55 (37.2)	31 (32.3)	24 (42.8)	$\chi^2 = 0.726$	0.394
Length of disease (years)	10 (2–20)	7 (2–14)	13 (6–20)	$Z = 6.354$	<0.001
Cough	113 (76.4)	65 (70.7)	48 (85.7)	$\chi^2 = 4.374$	0.036
Expectoration	108 (72.9)	62 (67.4)	46 (82.1)	$\chi^2 = 3.841$	0.050
Hemoptysis	43 (29.1)	24 (26.1)	19 (33.9)	$\chi^2 = 1.038$	0.308
FEV1, % predicted	60.0 (35.9–78.0)	66.0 (52.0–81.0)	44.5 (29.0–72.7)	$Z = -3.470$	<0.001
mMRC dyspnea score	2 (1–2)	1 (1–2)	2 (1–3)	$Z = 4.563$	<0.001
Lobes affected on HRCT	3 (2–3)	2 (1–2)	3 (2–3)	$Z = 2.550$	0.048
Exacerbations in previous 12 months	1 (0–3)	1 (0–2)	2 (1–3)	$Z = 2.936$	0.045
<i>P. aeruginosa</i> colonization				Fisher	0.179
No	138 (93.2)	88 (95.7)	50 (89.3)		
Yes	10 (6.8)	4 (4.3)	6 (10.7)		
Colonization with other organisms				Fisher	0.054
No	140 (94.6)	90 (97.8)	50 (89.3)		
Yes	8 (5.4)	2 (2.2)	6 (10.7)		
Hospitalizations within last 2 years				$\chi^2 = 31.067$	<0.001
No	90 (60.8)	72 (78.3)	18 (32.1)		
Yes	58 (39.2)	20 (21.7)	38 (67.9)		
BSI score	8.0 (4.0–10.0)	6 (4–8)	10.5 (9–14)	$Z = 6.969$	<0.001
FACED score	2 (0–3)	1 (0–2)	3 (1–4)	$Z = 5.185$	<0.001
E-FACED score	3 (1–5)	2 (1–3)	5 (3–6)	$Z = 6.125$	<0.001

Quantitative data were described as mean \pm standard deviation or median (interquartile range) while qualitative variables were expressed as n (%), unless otherwise stated. BMI: Body mass index; FEV1: Forced expiratory volume in 1 s; mMRC: Modified Medical Research Council; HRCT: High resolution computerized tomography. BSI: Bronchiectasis severity index; FACED: forced expiratory volume in 1 s %predicted (F), age (A), presence of chronic colonisation by *Pseudomonas aeruginosa* (*P. aeruginosa*, C), radiological extension (number of pulmonary lobes affected) (E), dyspnoea (D); E-FACED: FACED plus exacerbations in the previous year.

higher AUCs than the female group in all of the three scores, but no statistical difference was found in DeLong test [Supplementary Tables 5, <http://links.lww.com/CM9/A287> and 6, <http://links.lww.com/CM9/A287>].

Furthermore, cut-off values of BSI, FACED, and E-FACED to predict the readmission in this study were respectively 6.5 (sensitivity 0.893, specificity 0.827), 2.5 (sensitivity 0.757, specificity 0.714), and 3.5 (sensitivity 0.811, specificity 0.763).

The relatively higher rate of readmission due to bronchiectasis exacerbation may be attributable to the pathophysiological changes of bronchiectasis, which is defined as persistent or recurrent bronchial sepsis related to irreversibly damaged and dilated bronchi.^[5]

BSI was found to be the most efficient among the three tools in predicting bronchiectasis readmission. This might be related to BSI score, including both number of exacerbations and history of hospital admission. A prospective study suggests the presence of frequent exacerbations is as a prognostic value for overall mortality after 5 years of follow-up.^[6] In this study, the median number of exacerbations in the prior year of re-hospitalized patients are greater than that of non-rehospitalized patients ($P=0.045$), with the re-hospitalized patients having a markedly higher proportion in history of hospitalizations within last 2 years than the non-rehospitalized patients ($P<0.001$). Number of lobes affected is included in all three scores. The BSI score accumulates 1 point for at least three lobes affected, while the FACED and E-FACED scores both get 1 point for at least two lobes affected.^[1-3] The results of this study showed that the median number of lung lobes affected is three in re-hospitalized patients and in non-rehospitalized patients is two, supporting the superiority of the BSI score in predicting bronchiectasis readmission.

P. aeruginosa infection is also one of indicators included in all of the three scores. Chronic infection with *P. aeruginosa* affecting 10% to 40% of adults with bronchiectasis is associated with an increased exacerbation frequency.^[1-5] Chronic *P. aeruginosa* infection is associated with an independent increased risk of hospital admissions and exacerbations, as well as being related to worse prognosis in adult with bronchiectasis disease.^[4] The results of this study present that *P. aeruginosa* is found in 10.7% of the rehospitalized patients and only 4.3% of the non-rehospitalized patients, indicating that readmission group might have a higher infection trend, while the difference is not statistically significant.

On the whole, through this prospective study, we concluded that all the three scoring systems are available for predicting the risk of readmission for patients with bronchiectasis due to exacerbation, and BSI is the preferred one. However, these results are an internal validation, and further validation on an external dataset is required. In addition, because this is an observational single center study with relatively small sample size, the results are slightly rough. In the future, multicenter clinical studies with larger sample size and longer period of follow-up are needed to further confirmation of clinical value of different bronchiectasis scoring systems, and probably, to modify the existed or to develop new tools. The application of multidimensional severity scoring systems may help to monitor the disease and guide management of bronchiectasis.

Funding

This work was supported by a grant from the Beijing Municipal Administration of High Level Health Technical Personnel Training Plan, China (No. 2015-3-027).

Conflicts of interest

None.

References

1. Wang N, Qu JM, Xu JF. Bronchiectasis management in China, what we can learn from European Respiratory Society guidelines. *Chin Med J* 2018;131:1891–1893. doi: 10.4103/0366-6999.238134.
2. Chalmers JD, Goeminne P, Aliberti S, McDonnell MJ, Lonni S, Davidson J, *et al.* The bronchiectasis severity index. An international derivation and validation study. *Am J Respir Crit Care Med* 2014;189:576–585. doi: 10.1164/rccm.201309-1575OC.
3. Martinez-Garcia MA, de Gracia J, Vendrell Relat M, Giron RM, Maiz Carro L, de la Rosa Carrillo D, *et al.* Multidimensional approach to non-cystic fibrosis bronchiectasis: the FACED score. *Eur Respir J* 2014;43:1357–1367. doi: 10.1183/09031936.00026313.
4. Martinez-Garcia MA, Athanazio RA, Giron R, Maiz-Carro L, de la Rosa D, Oliveira C, *et al.* Predicting high risk of exacerbations in bronchiectasis: the E-FACED score. *Int J Chron Obstruct Pulmon Dis* 2017;12:275–284. doi: 10.2147/COPD.S121943.
5. Hill AT, Sullivan AL, Chalmers JD, De Soyza A, Elborn SJ, Floto AR, *et al.* British Thoracic Society Guideline for bronchiectasis in adults. *Thorax* 2019;74:1–69. doi: 10.1136/thoraxjnl-2018-212463.
6. Martinez-Garcia MA, Athanazio R, Gramblicka G, Corso M, Cavalcanti Lundgren F, Fernandes de Figueiredo M, *et al.* Prognostic value of frequent exacerbations in bronchiectasis: the relationship with disease severity. *Archivos de Bronconeumologia* 2019;55:81–87. doi: 10.1016/j.arbres.2018.07.002.

How to cite this article: Wang XY, Li R, Wang WY, Li DS, Zhou YY, Chen XT, Bu XN. Bronchiectasis severity assessment on predicting hospital readmission: a single-center prospective cohort study. *Chin Med J* 2021;134:492–494. doi: 10.1097/CM9.0000000000001051