 Developing a diagnostic bundle for bronchiectasis in South Korea: A modified Delphi Consensus Study

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Running title: Bronchiectasis diagnostic bundle in South Korea

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Conceptualization: Choi H, Lee H, Ra SW, and Oh YM. Methodology: Choi H, Lee H, Ra SW, and Oh YM. Formal analysis: Choi H and Oh YM. Data curation: Choi H. Investigation: Choi H, Lee H, Ra SW, and Oh YM. Original draft preparation: Choi H and Oh YM. Review and editing: all authors. Approval of final manuscript: all authors.
Abstract

Background
A diagnostic bundle for bronchiectasis in South Korea is necessary because the etiologies of bronchiectasis and related diseases vary significantly among different regions and ethnicities.

Methods
A modified Delphi method was used to develop expert consensus statements on a diagnostic bundle for bronchiectasis in South Korea. Initial statements proposed by a core panel, based on international bronchiectasis guidelines, were discussed over one online meeting and two email surveys by a panel of experts (≥70% agreement).

Results
Twenty-one experts participated in the study, and 30 statements on a diagnostic bundle for bronchiectasis were classified as recommended, conditional, or not recommended. The expert panel agreed that 1) a standardized diagnostic bundle is useful in clinical practice, 2) diagnostic tests for specific diseases, including immunodeficiency and allergic bronchopulmonary aspergillosis, are necessary when clinically suspected, 3) initial diagnostic tests, including sputum microbiology and spirometry, are essential in all bronchiectasis patients, and 4) patients should be referred to specialized centers when rare causes such as primary ciliary dyskinesia are suspected.

Conclusion
In this Delphi survey, expert consensus statements were generated on which specific diagnostic, laboratory, microbiologic, and pulmonary function tests to obtain when managing patients with bronchiectasis in South Korea.

Keywords: Bronchiectasis, Diagnosis, Consensus guideline, Korea, Survey
Introduction

Bronchiectasis is a chronic respiratory disease characterized by abnormal dilatation of the bronchi, which presents clinically with cough, sputum production, and recurrent infection\textsuperscript{1,2}. As the prevalence and disease burden of bronchiectasis has increased worldwide\textsuperscript{3-6}, the prevalence and disease burden of this disease has become substantial in South Korea\textsuperscript{1,7-9}. One of the obstacles to adequately addressing the disease burden of bronchiectasis is its heterogeneity\textsuperscript{10,11}, as it may be caused by or related to many respiratory or systemic diseases\textsuperscript{12,13}.

Given the heterogeneity of the disease, a systematic etiologic evaluation is recommended by various international bronchiectasis guidelines\textsuperscript{14,15}. Determining the etiology is of paramount importance in order to prescribe appropriate treatment and improve patients’ outcomes\textsuperscript{16,17}. The international bronchiectasis guidelines, which suggest a minimum diagnostic bundle as a part of the systematic approach, have a crucial role in the management of patients with bronchiectasis\textsuperscript{15}. However, there are significant differences in the etiology and comorbidities of bronchiectasis among different countries and regions\textsuperscript{10}.

It may be inappropriate to apply the diagnostic bundles suggested by other international societies without modification for the management of patients with bronchiectasis in South Korea. This study aimed to develop a diagnostic bundle for patients with bronchiectasis in South Korea.

Materials and Methods

1. Study design

This study incorporated a two-step, modified Delphi method\textsuperscript{18} focusing on developing a diagnostic bundle for bronchiectasis in South Korea. The Delphi method is recommended
for use in the healthcare setting as a reliable means of determining consensus for a defined clinical problem\textsuperscript{19,20}. Initially, a comprehensive list of items was identified, and a set of statements was made by four core panelists (HC, HL, SWR, and YMO) which was based on recently published international guidelines for bronchiectasis\textsuperscript{14,15}. The draft document containing the list of statements was circulated by email to all panel members. Subsequently, an online meeting (March 8, 2021) attended by an expert panel (see below) took place before initiation of two rounds of Delphi surveys. During the process, a set of statements was modified and updated based on the expert panel’s feedback (Figure 1). The study protocol was approved by the Institutional Review Board of Asan Medical Center (application no. 2021-0218).

2. Panel selection

Panel members were identified from study groups of the Korean Academy of Tuberculosis and Respiratory Diseases, the official Korean society of respiratory physicians, based on their clinical and research expertise in the diagnosis and treatment of bronchiectasis. Twenty-one experts were initially contacted and asked to participate in consensus development. Among the 21 expert panels, 20 experts were chosen from three study groups of the Korean Academy of Tuberculosis and Respiratory Diseases: 16 from the Bronchiectasis Study Group (four of the 16 were the core panel members), two from the Chronic Obstructive Pulmonary disease Study Group, and two from the Tuberculosis Study Group. Additionally, one pediatrician who are an expert in the field of primary ciliary dyskinesia was also included in the expert panel, and the other perdiatrician who are an expert in the field of primary immunodeficiency served as a consultant (not as a panelist) during the study period. All 21 experts provided consent and agreed to participate. Of the 21 experts, 20 responded to both rounds of the survey.
3. Survey round 1

A document containing a set of statements was circulated by email to all experts. The document had five sections and 30 statements. Panel members could choose one of the following answers to each statement: strongly agree, agree, neutral, disagree, and strongly disagree.

The agreement rate was defined as the percentage of panel members who answered, “strongly agree” or “agree.” The disagreement rate was defined as the percentage of panel members who answered “disagree” or “strongly disagree.” Additionally, at the end of the document, there was a questionnaire on an optimal cutoff for an agreement rate to recommend a particular diagnostic bundle for bronchiectasis (Table 1). Panel members could also write their suggestions and feedback in free text form in the document.

4. Survey round 2

A document for the round 2 survey was composed based on the results of the round 1 survey and feedback from the experts. This survey was emailed to all panel members who responded during round 1. In round 2, the experts used the same voting method as described for round 1. The document for round 2 also provided the expert panel’s agreement/disagreement rates. Based on the results of round 2, a third survey or an online meeting would be considered if indicated. The final version of the round 2 survey is shown in Table 2.

5. Analysis

The panel’s opinions on a diagnostic bundle for bronchiectasis were collected from the round 1 and round 2 Delphi-method surveys. At the panel’s recommendation, a 70%/30%
cutoff was used to decide whether to recommend the statement or not. If there was ≥70% agreement with a statement, it would be recommended. If there was a ≥ 30% but <70% agreement with a statement, it would be considered conditional based on the choice of the physician and patient. If there was < 30% agreement with a statement it would not be recommended.

**Results**

The first survey was circulated by email between March 24, 2021 and April 15, 2021. The response rate was 95% (n = 20/21). In the overview section, most experts agreed on the necessity for a diagnostic bundle for bronchiectasis. Although there were differences of opinion regarding the need to test for immunodeficiency, most experts agreed on the need for additional testing for younger (< 50 years) bronchiectasis patients without a definite cause and on referral to other institutions where diagnostic testing was available when cystic fibrosis (upper lung lobes predominance, gastrointestinal symptoms due to malabsorption, pancreatitis, diabetes mellitus, and infertility), primary ciliary dyskinesia (middle and lower lung lobes predominance, sinusitis, recurrent otitis media, situs inversus, and infertility), and alpha-1 antitrypsin deficiency (panacinar emphysema in lower lung lobes) were suspected. In the pulmonary function testing and microbiologic testing sections, most experts agreed on pre- and post-bronchodilator spirometry, Gram stain and bacterial culture, and acid fast bacilli stain and culture. However, there were differences of opinion regarding other pulmonary function and microbiological tests. Most panelists agreed on the need for laboratory tests during a patient’s stable state as well as paranasal sinus X-rays when bronchiectasis was diagnosed. The specific rates of agreement and disagreement from the round 1 survey are noted in Table 1.
The second survey was also circulated by email between May 7, 2021 and May 13, 2021. The document was sent to the 20 experts who responded to the round 1 survey. The round 2 survey had a 100% response rate. The round 2 survey attempted to narrow the discrepancies found in the round 1 survey. Expert panelists did not recommend testing for allergic bronchopulmonary aspergillosis (ABPA), immunodeficiency, autoimmune diseases, and chronic pulmonary aspergillosis in all patients with bronchiectasis. Instead, they recommend those tests only when the diseases were clinically suspected as follows: 1) ABPA in patients with uncontrolled asthma and recurrent pulmonary opacities, 2) immunodeficiency in those with a history of recurrent infections or comorbidities of hematological malignancies, 3) autoimmune diseases in those with known connective tissue diseases (especially rheumatoid arthritis) or suspected symptoms of connective tissue diseases, and 4) chronic pulmonary aspergillosis in those with a several month history of chronic productive cough (or hemoptysis) and one or more cavities on chest X-rays\textsuperscript{14,15,21}. Detailed rates of agreement and disagreement from the round 2 survey are noted in Table 2 and Figure 2. Table 3 summarizes the results of the modified Delphi survey on a diagnostic bundle for bronchiectasis in South Korea. All 30 statements are classified into three categories as recommended, conditional, or not recommended. There were 20 recommendations, including when to order specific tests to determine etiology, when to refer patients to more specialized centers, and specific microbiological, laboratory, radiological, and pulmonary function tests. Additionally, there were five conditionally recommended statements and five not recommended statements.

Discussion

In this study, in which 21 experts participated, 30 statements on a diagnostic bundle for bronchiectasis were classified as recommended, conditional, or not recommended. An expert
panel agreed that 1) a standardized diagnostic bundle is useful in clinical practice, 2) diagnostic tests for specific diseases, including immunodeficiency, ABPA, and rheumatologic diseases should be performed when clinically suspected, 3) initial diagnostic tests, including sputum microbiology, complete blood count, blood chemistry, chest computed tomography, paranasal X-ray, and spirometry are essential in all patients with bronchiectasis, and 4) patients should be referred to specialized centers when rare causes such as primary ciliary dyskinesia, cystic fibrosis, and alpha-1 antitrypsin deficiency are suspected.

As previously noted in the international guideline, this study also found that all experts agreed that a standardized diagnostic bundle for bronchiectasis is useful in clinical practice. In line with this recommendation, a previous study noted that a standardized etiological algorithm in bronchiectasis had reduced the diagnosis of idiopathic bronchiectasis from 42% to 29%. Given the substantial differences in bronchiectasis etiology and clinical presentation among different regions and ethnic groups, the development of a diagnostic bundle for bronchiectasis optimized for the population in South Korea is necessary. This expert consensus will be the cornerstone for the future development of the Korean bronchiectasis guideline, and study results from the Korean Multicentre Bronchiectasis Audit and Research Collaboration (KMBARC) will be incorporated into that guideline.

In this study, the experts recommended diagnostic tests that are currently in recently released international bronchiectasis guidelines. Identification of nontuberculous mycobacteria, commonly isolated in patients with bronchiectasis, has a role in diagnosing treatable etiologies and improving long-term outcomes. Diagnosing chronic infections with Pseudomonas or other bacteria may also explain why some patients experience severe disease and exacerbations more frequently. This microbiological information can assist clinicians in diminishing symptom burdens and future exacerbation risks. Similarly, pulmonary function tests, recommended by most experts in this study, play a role in estimating the
mortality of patients with bronchiectasis and determining which patients might benefit from bronchodilators.

Interestingly, there were some discrepancies between the panel’s recommendations in this study and international guidelines. Tests for ABPA were not recommended for all patients with bronchiectasis but only in those with a history of asthma. However, tests for ABPA are included in a minimum diagnostic bundle of the European Respiratory Society and the British Thoracic Society guidelines. Additionally, although the British Thoracic Society guideline recommends testing for immunoglobulins and specific antibody to *Streptococcus pneumoniae* capsular polysaccharides in all patients with bronchiectasis, the current panel recommended the tests only in specific subpopulations. These discrepancies may reflect the fact that the experts still encounter post-infective, including post-tuberculosis (TB), bronchiectasis as a major portion of bronchiectasis in their real-world practice. Additionally, this could also be due to limited availability to measure specific antibody to *Streptococcus pneumoniae* capsular polysaccharides in South Korea and relatively low-level of awareness for primary immunodeficiency among physicians. The KMBARC registry data noted that the most common etiologies of bronchiectasis were idiopathic (41%), TB (20%), post-infective (20%), asthma (5%), and nontuberculous mycobacteria (4%) in South Korea. However, the decrease of TB incidence in the past decades in South Korea will likely change the major etiologies of bronchiectasis in the future. Additionally, developing a diagnostic bundle to evaluate the etiology of bronchiectasis systematically may decrease the rate of idiopathic disease resulting in changes in the major etiologies in South Korea. Thus, future reviews of the Korean bronchiectasis registry are warranted, and the diagnostic bundle may need to be updated according to the study results.

There are potential limitations to this study. First, because most experts are respiratory physicians working at secondary or tertiary university-affiliated hospitals, all of the diagnostic
tests recommended by this study may not be available in primary care settings. Second, this study focused on the development a diagnostic bundle for adult patients with bronchiectasis. Therefore, future study is needed to develop a diagnostic bundle for pediatric patients with bronchiectasis. In contrast, two pediatricians, participating in this study, are experts in the field of primary ciliary dyskinesia and immunodeficiency respectively, which is a strength of this study.

In conclusion, in this Delphi survey, expert consensus statements were generated on specific diagnostic tests for determining the etiology and appropriate laboratory, microbiological, and pulmonary function tests when managing patients with bronchiectasis in South Korea.

**Conflicts of Interest**

No potential conflict of interest relevant to this article was reported.

**Acknowledgments**

We would like to thank Sang Yong Sim, RN for his help and support in conducting the study.

**Funding**

None.
References


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27. Lee H, Oh YM. Clinical Approach to Non-cystic fibrosis Bronchiectasis Based on


Table 1. Survey round 1: Questions and agreement/disagreement rates.

<table>
<thead>
<tr>
<th>Section 1. Overview</th>
<th>Agreement/Neutral/Disagreement rates*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1  A standardized diagnostic bundle for bronchiectasis is useful in clinical practice.</td>
<td>95%/5%/0%</td>
</tr>
<tr>
<td>Q2  In patients &lt; 50 years of age without a definite cause of bronchiectasis, additional tests should be performed to elucidate the etiology. The additional testing may include tests for primary ciliary dyskinesia, cystic fibrosis, alpha 1 antitrypsin deficiency, and immunoglobulin deficiency.</td>
<td>80%/15%/5%</td>
</tr>
</tbody>
</table>

Section 2. Tests to search for the causes of bronchiectasis

| Q3  All patients should receive a chest CT when first diagnosed with bronchiectasis. | 95%/5%/0%                             |
| Q4  All patients should receive tests related to ABPA such as a CBC, total Ig E, specific Ig E, or skin test for *Aspergillus fumigatus* | 35%/25%/40%                          |
| Q5  Tests related to ABPA should be performed only in bronchiectasis patients with a history of asthma. | 60%/5%/35%                            |
| Q6  Serum Ig levels (Ig G, Ig A, and Ig M) should be measured in all patients when first diagnosed with bronchiectasis. | 40%/30%/30%                           |
| Q7  Serum Ig levels (B cell immunity) should be measured only when immunodeficiency (e.g., recurrent infections) is suspected. | 60%/10%/30%                           |
Q8 A baseline level of antibody specific to *Streptococcus pneumoniae* capsular polysaccharides should be measured in all patients when first diagnosed with bronchiectasis.

Q9 If the baseline level of specific antibody to *Streptococcus pneumoniae* capsular polysaccharides is low, it should be remeasured 4–8 weeks after pneumococcal 23 polyvalent vaccine injection.

Q10 A baseline level of antibody specific to *Streptococcus pneumoniae* capsular polysaccharides should be measured only when immunodeficiency is suspected.

Q11 Repetitive measurement of antibody specific to *Streptococcus pneumoniae* capsular polysaccharides should be performed 4–8 weeks after pneumococcal 23 polyvalent vaccine injection only when immunodeficiency is suspected and the baseline level was low.

Q12 Autoimmune markers (FANA, RF, antiCCP, ANCA) should be measured in all patients when first diagnosed with bronchiectasis.

Q13 Autoimmune markers should be measured only when rheumatologic diseases are suspected.

Q14 When primary ciliary dyskinesia is suspected, clinicians should refer patients to institutions where diagnostic tests are available.

Q15 In patients < 50 years of age without a definite cause of bronchiectasis, questionnaires of high diagnostic sensitivity
should be used for the differential diagnosis of primary ciliary dyskinesia.

Q16 When alpha-1 antitrypsin deficiency is suspected, clinicians should refer patients to institutions where diagnostic tests are available.

Q17 If patients < 50 years of age do not have a definite cause of bronchiectasis and demonstrate panacinar emphysema on basal lung CXR, tests for alpha-1 antitrypsin deficiency should be performed.

Q18 When cystic fibrosis is suspected, clinicians should refer patients to institutions where diagnostic tests are available.

Section 3. Pulmonary function tests and microbiological tests

Q19 Prebronchodilator spirometry should be performed in all patients when first diagnosed with bronchiectasis.

Q20 Postbronchodilator spirometry should be performed simultaneously with prebronchodilator spirometry in all patients when first diagnosed with bronchiectasis.

Q21 Diffusion capacity should be measured if indicated when first diagnosed with bronchiectasis.

Q22 Lung volume should be measured if indicated when first diagnosed with bronchiectasis.

Q23 Sputum Gram stain and bacterial culture should be performed in all patients when first diagnosed with bronchiectasis.

Q24 Sputum AFB stain and culture should be performed in all patients when first diagnosed with bronchiectasis.
Q25  Sputum fungal culture should be performed in all patients when first diagnosed with bronchiectasis. 50%/25%/25%

Q26  All patients should receive testing for chronic pulmonary aspergillosis when first diagnosed with bronchiectasis. 0%/45%/55%

Q27  Tests for chronic pulmonary aspergillosis should be performed when patients with bronchiectasis have chronic pulmonary disease and chronic pulmonary aspergillosis is suspected. 95%/5%/0%

Section 4. Laboratory tests

Q28  All patients should receive laboratory testing, including CBC, liver function tests, BUN, creatinine, and CRP when they are in a stable state. 95%/5%/0%

Section 5. Paranasal sinus tests

Q29  All patients should receive PNS X-ray when first diagnosed with bronchiectasis. 90%/5%/5%

Q30  All patients should receive PNS CT when first diagnosed with bronchiectasis. 5%/15%/80%

Optimal cutoff for analyzing survey results

Q31  What is the optimal cutoff for analyzing survey results? A) 71%

(A 70%/30% cutoff means a statement with ≥ 70% agreement should be recommended, a statement with ≥ 30% and <70% agreement rate should be considered as conditional based on the choice of the physician and patient, and a statement with <30% agreement should not be recommended.)

A) 70%/30% B) 80%/30% C) 70%/20% D) 80%/20%
ABPA, allergic bronchopulmonary aspergillosis; AFB, acid fast bacilli; ANCA, antineutrophil cytoplasmic antibodies; anti-CCP, anti-cyclic citrullinated peptide; BUN, blood urea nitrogen; CBC, complete blood count; CRP, C-reactive protein; CT, computed tomography; FANA, fluorescent antinuclear antibody; Ig, immunoglobulin; PNS, paranasal sinus; RF, rheumatoid factor.

*Agreement rate was defined as the percentage of experts who answered, “strongly agree” or “agree,” and the disagreement rate was the percentage who answered “disagree” or “strongly disagree.”
Table 2. Survey round 2: Questions and agreement/disagreement rates.

*Choose one of the answers to each statement.*

<table>
<thead>
<tr>
<th>Question</th>
<th>Statement</th>
<th>Agreement/Neutral/Disagreement rates*</th>
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<tbody>
<tr>
<td>Section 1. Overview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>A standardized diagnostic bundle for bronchiectasis is useful in clinical practice.</td>
<td>100%/0%/0%</td>
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<tr>
<td>Q2</td>
<td>In patients &lt; 50 years of age without definite cause of bronchiectasis, additional tests should be performed to elucidate the etiology beyond a specific diagnostic bundle.</td>
<td>80%/20%/0%</td>
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<tr>
<td>Section 2. Tests to search for the causes of bronchiectasis</td>
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<tr>
<td>Q3</td>
<td>All patients should receive a chest CT when first diagnosed with bronchiectasis.</td>
<td>95%/5%/0%</td>
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<tr>
<td>Q4</td>
<td>All patients should receive tests to elucidate eosinophilic endotype (CBC, total Ig E) when first diagnosed with bronchiectasis.</td>
<td>55%/15%/30%</td>
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<tr>
<td>Q5</td>
<td>All patients should receive tests related to ABPA when first diagnosed with bronchiectasis.</td>
<td>15%/30%/55%</td>
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<tr>
<td>Q6</td>
<td>Tests related to ABPA should be performed only in bronchiectasis patients with a history of asthma.</td>
<td>80%/5%/15%</td>
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<tr>
<td>Q7</td>
<td>Serum Ig levels should be measured in patients &lt; 50 years of age when first diagnosed with bronchiectasis.</td>
<td>65%/15%/20%</td>
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<tr>
<td>Q8</td>
<td>Serum Ig levels should be measured only when immunodeficiency is suspected.</td>
<td>70%/5%/25%</td>
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</table>
Q9 A baseline level of antibody specific to *Streptococcus pneumoniae* capsular polysaccharides should be measured in all patients when first diagnosed with bronchiectasis. 0%/15%/85%

Q10 A baseline level of antibody specific to *Streptococcus pneumoniae* capsular polysaccharides should be measured only when immunodeficiency is suspected. 90%/10%/0%

Q11 Repetitive measurement of antibody levels specific to *Streptococcus pneumoniae* capsular polysaccharides should be performed 4–8 weeks after pneumococcal 23 polyvalent vaccine injection only when immunodeficiency is suspected and the baseline level was low. 85%/15%/0%

Q12 Autoimmune markers should be measured in patients < 50 years of age when first diagnosed with bronchiectasis. 50%/25%/25%

Q13 Autoimmune markers should be measured only when rheumatologic diseases are suspected. 95%/5%/0%

Q14 When primary ciliary dyskinesia is suspected, clinicians should refer patients to institutions where diagnostic tests are available. 100%/0%/0%

Q15 In patients < 50 years of age without a definitive cause of bronchiectasis, questionnaires with a high diagnostic sensitivity should be used for the differential diagnosis of primary ciliary dyskinesia. 100%/0%/0%

Q16 When alpha-1 antitrypsin deficiency is suspected, clinicians should refer patients to institutions where diagnostic tests are available. 100%/0%/0%
Q17 If patients < 50 years of age do not have a definitive cause of bronchiectasis and demonstrate panacinar emphysema on basal lung CXR, tests for alpha-1 antitrypsin deficiency should be performed.

Q18 When cystic fibrosis is suspected, clinicians should refer patients to institutions where diagnostic tests are available.

Section 3. Pulmonary function tests and microbiological tests

Q19 Prebronchodilator spirometry should be performed in all patients when first diagnosed with bronchiectasis.

Q20 Postbronchodilator spirometry should be performed in all patients when first diagnosed with bronchiectasis.

Q21 Diffusion capacity should be included in a diagnostic bundle for bronchiectasis.

Q22 Lung volume should be included in a diagnostic bundle for bronchiectasis.

Q23 Sputum Gram stain and bacterial culture should be performed in all patients when first diagnosed with bronchiectasis.

Q24 Sputum AFB stain and culture should be performed in all patients when first diagnosed with bronchiectasis.

Q25 Sputum fungal culture should be performed in all patients when first diagnosed with bronchiectasis.

Q26 All patients should receive tests for chronic pulmonary aspergillosis when first diagnosed with bronchiectasis.

Q27 Tests for chronic pulmonary aspergillosis should be performed only when chronic pulmonary aspergillosis is suspected.
Section 4. Laboratory tests

Q28 All patients should receive laboratory testing, including CBC, liver function tests, BUN, creatinine, and CRP, when they are in a stable state. 95%/0%/5%

Section 5. Paranasal sinus tests

Q29 All patients should receive a PNS X-ray when first diagnosed with bronchiectasis. 90%/5%/5%

Q30 All patients should receive a PNS CT when first diagnosed with bronchiectasis. 0%/10%/90%

Optimal cutoff for analyzing survey results

Q31 Which is the optimal cutoff for analyzing survey results? A) 85%
   (A 70%/30% cutoff means a statement with ≥ 70% agreement should be recommended, a statement with ≥ 30% and <70% agreement rate should be considered as conditional based on the choice of physician and patient, and a statement with < 30% agreement should not be recommended) B) 5%
   C) 5%
   D) 5%

A) 70%/30% B) 80%/30% C) 70%/20% D) 80%/20%

AGPA, allergic bronchopulmonary aspergillosis; AFB, acid fast bacilli; BUN, blood urea nitrogen; CBC, complete blood count; CRP, C-reactive protein; CT, computed tomography; Ig, immunoglobulin; PNS, paranasal sinus;

*Agreement rate was defined as the percentage of experts who answered “strongly agree” or “agree.” The disagreement rate was the percentage of experts who answered “disagree” or “strongly disagree.”
Table 3. Recommended diagnostic bundle for bronchiectasis in South Korea.

<table>
<thead>
<tr>
<th>Recommended</th>
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<td>11</td>
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</tbody>
</table>
If patients < 50 years of age do not have a definite cause of bronchiectasis and demonstrate panacinar emphysema on basal lung CXR, tests for alpha-1 antitrypsin deficiency should be performed.

When cystic fibrosis is suspected, clinicians should refer patients to institutions where diagnostic tests are available.

Prebronchodilator spirometry should be performed in all patients when first diagnosed with bronchiectasis.

Postbronchodilator spirometry should be performed in all patients when first diagnosed with bronchiectasis.

Sputum Gram stain and bacterial culture should be performed in all patients when first diagnosed with bronchiectasis.

Sputum AFB stain and culture should be performed in all patients when first diagnosed with bronchiectasis.

Tests for chronic pulmonary aspergillosis should be performed only when chronic pulmonary aspergillosis is suspected.

All patients should receive laboratory testing, including CBC, liver function tests, BUN, creatinine, and CRP when they are in a stable state.

All patients should receive a PNS X-ray when first diagnosed with bronchiectasis.

Conditional

<table>
<thead>
<tr>
<th>1</th>
<th>All patients receive tests to evaluate eosinophilic endotype (CBC, total Ig E) when first diagnosed with bronchiectasis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Serum Ig levels can be measured in patients &lt; 50 years of age when first diagnosed with bronchiectasis.</td>
</tr>
<tr>
<td>3</td>
<td>Autoimmune markers can be measured in patients &lt; 50 years of age when first diagnosed with bronchiectasis.</td>
</tr>
</tbody>
</table>
4 Diffusion capacity can be included in a diagnostic bundle for bronchiectasis.
5 Lung volume can be included in a diagnostic bundle for bronchiectasis.

<table>
<thead>
<tr>
<th>Not recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 All patients should not receive tests related to ABPA when first diagnosed with bronchiectasis.</td>
</tr>
<tr>
<td>2 A baseline level of antibody specific to <em>Streptococcus pneumoniae</em> capsular polysaccharides should not be measured in all patients when first diagnosed with bronchiectasis.</td>
</tr>
<tr>
<td>3 A sputum fungal culture should not be performed in all patients when first diagnosed with bronchiectasis.</td>
</tr>
<tr>
<td>4 All patients should not receive tests for chronic pulmonary aspergillosis when first diagnosed with bronchiectasis.</td>
</tr>
<tr>
<td>5 All patients should not receive a PNS CT when first diagnosed with bronchiectasis.</td>
</tr>
</tbody>
</table>

If age (e.g. less than 50 years old) is not specified, those statements are applied to adults of all ages.

ABPA, allergic bronchopulmonary aspergillosis; AFB, acid fast bacilli; BUN, blood urea nitrogen; CBC, complete blood count; CRP, C-reactive protein; CT, computed tomography; Ig, immunoglobulin; PNS, paranasal sinus.
Figure legends

Figure 1. Process of a modified Delphi method.
Figure 2. Survey round 2 results.

<50, < 50 years of age; Ab, antibody; ABPA, allergic bronchopulmonary aspergillosis; AFB, acid fast bacilli; A1AD, alpha-1 antitrypsin deficiency; CBC, complete blood count; CF, cystic fibrosis; CPA, chronic pulmonary aspergillosis; CT, computed tomography; Ig, immunoglobulin; PCD, primary ciliary dyskinesia; PNS, paranasal sinus.