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Brief Communication

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Bacterial Etiology in Subacute Cough

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ABSTRACT

Although postinfectious etiology is the most common cause of subacute cough, there are insufficient data on the epidemiology of associated bacterial infections. We aimed to identify the etiology of bacterial detection in subjects with subacute cough. A multicenter prospective observational study of 142 patients with postinfectious subacute cough was performed between August 2016 and December 2017 in Korea. We obtained 2 nasal swabs from each patient and used a multiplex bacterial polymerase chain reaction (PCR) kit that simultaneously detects *Bordetella pertussis*, *Chlamydophila pneumoniae*, *Haemophilus influenzae*, *Legionella pneumophilia*, *Mycoplasma pneumoniae*, and *Streptococcus pneumoniae*. About 29% (n = 41) of patients with subacute cough were positive for bacterial PCR in nasal swabs. The most common bacteria detected by bacterial PCR was *H. influenzae* (n = 19, 13.4%), followed by *S. pneumoniae* (n = 18, 12.7%), *B. pertussis* (n = 7, 4.9%), *M. pneumoniae* (n = 3, 2.1%), *L. pneumophilia* (n = 2, 1.4%), and *C. pneumoniae* (n = 1, 0.7%). Nine patients had dual positivity for the PCR. In conclusion, bacterial PCR was positive in the nasal swabs of about 29% of subjects with subacute cough, including 5% of positive PCR results for *B. pertussis*.

Keywords: Cough; bacteria; polymerase chain reaction; *Bordetella pertussis*

INTRODUCTION

Cough is one of the most common respiratory symptoms that patients seek treatment for in outpatient visits.[1-3] Cough is classified into 3 categories based on duration as follows: acute (less than 3 weeks), subacute (3 to 8 weeks), and chronic (more than 8 weeks).[2-4]

Due to persistent symptoms and troublesome issues compared to acute or subacute cough, most studies focus on chronic cough,[5-7] while only a few studies are available regarding subacute cough.[4] The common etiology of subacute cough is post-infection.[4] Postinfectious etiology of subacute cough is usually made based on clinical history, in which the cough was initiated by upper respiratory infection and did not meet other disease entities.[4] While the infection

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is the most common etiology, few studies have evaluated the microorganisms associated with subacute cough, most likely due to the self-limiting nature of subacute cough[8] and the prevailing thought that subacute cough is caused by viral infections. However, this practice has led to insufficient data on the bacterial etiology of subacute cough. Evaluating the bacterial etiology of subacute cough is important due to the potential benefit of antibiotic treatment.

There has been recent great concern surrounding the underestimated and underreported burden of pertussis in Korea.[9,10] Since cough is the most common presentation of pertussis, it can serve as an important cause of subacute cough.[9,11] Due to its high infectivity, early diagnosis, antibiotic treatment, and quarantine are strongly recommended in patients with pertussis. Furthermore, considering the highly contagious characteristics of pertussis, the prevalence of pertussis-related subacute cough may be important in terms of public health management. However, few data are available on this issue. Therefore, we aimed to identify which bacteria, including *Bordetella pertussis,* are detected in patients with subacute cough.

MATERIALS AND METHODS

Study population

A multicenter prospective observational study of patients with postinfectious subacute cough was performed between August 1, 2016, and December 31, 2017. Subjects were enrolled from 6 hospitals in Korea (Gachon University Gil Medical Center, Hanyang University Hospital, Hanyang University Guri Hospital, Nowon Eulji Medical Center, Samsung Medical Center, and Seoul National University Bundang Hospital). To minimize the effects of seasonal variations, the study period for each institution was 12 months. The inclusion criteria were 1) adults ≥ 19 years of age and 2) cough lasting 3–8 weeks. The exclusion criteria were 1) abnormal findings of chest X-ray, 2) subacute cough caused by etiologies other than infections including asthma, chronic obstructive pulmonary disease, bronchiectasis, interstitial lung disease, lung cancer, pneumonia, tuberculosis, and/or sinusitis, 3) massive hemoptysis, 4) pregnant women, 5) currently using angiotensin-converting enzyme inhibitors, 6) immunocompromised patients (e.g., those with human immunodeficiency virus infection, receiving immunosuppressants or corticosteroid at least of 20 mg/day of prednisolone equivalents), 7) positive bronchoprovocation test (mannitol or methacholine), and 8) patients who did not agree to participate in the study. All subjects enrolled in this study provided informed consent. This study was approved by each institution's Institutional Review Board (IRB) (IRB No. 2016-07-001-010).

Definitions

Subacute cough was defined as a cough lasting 3 to 8 weeks, and postinfectious causes were determined by the patient's clinical history as assessed by attending physicians. Criteria were cough initiated by upper respiratory infection and did not meet other disease entities.[4] The patients who ever diagnosed or suspected asthma were excluded, while the patients under gastroesophageal reflux (GERD) treatment could be included unless the researcher determined GERD caused the cough.

Main outcomes

Our study aimed to evaluate the positive bacterial identification rate based on polymerase chain reaction (PCR) in subjects with subacute cough. Thereafter, we specifically focused on the positive PCR rate for *B. pertussis*.

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Data collection

Using a questionnaire, we collected age, sex, weight, height, smoking history, previous history of comorbidity including allergy, previous tuberculosis, previous history of pertussis, symptoms at the onset of cough, and at the time of outpatient visit. Cough symptoms were measured using the visual analog scale (VAS), Cough Symptom Score (CSS),[12] and Leicester Cough Questionnaire (LCQ).[13]

Multiplex bacterial PCR

We obtained 2 nasal swabs from each participant at the time of the outpatient visit. We used a multiplex bacterial PCR kit (Seeplex® PneumoBacter ACE detection; Seegene, Seoul, Korea) that can simultaneously detect *B. pertussis*, *Chlamydophila pneumoniae*, *Haemophilus influenzae*, *Legionella pneumophilia*, *Mycoplasma pneumoniae*, and *Streptococcus pneumoniae*. All analyses were performed according to the manufacturer's recommendations.

Statistical analysis

Categorical variables are presented as numbers (%) and compared using the χ^2 test or Fisher's exact test, as appropriate. Continuous variables are presented as mean ± standard deviation or median (interquartile range) and compared using the *t*-test or Mann-Whitney *U* test, as appropriate. A 2-sided *P* value < 0.05 was considered significant. All statistical analyses were performed using R version 4.1.0 (R core Team 2021; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Population

The median age was 40 years and 72.3% were female. The median body mass index was 22.8 kg/m^2. Only 2.4% of subjects had received pertussis vaccination within 10 years (**Table 1**). Of 142 patients with postinfectious subacute cough, 41 (28.9%) showed bacterial positivity in the nasal swab PCR. There were no significant differences in baseline characteristics including smoking status, comorbidities, or rate of taking antibiotics between the 2 groups.

Symptoms

There were no intergroup differences in associated symptoms, duration, orthe severity of cough measured by cough VAS ($P = 0.329$), CSS (daytime, $P = 0.731$; nighttime, $P = 0.235$), or LCQ ($P = 0.573$) (**Table 2**).

PCR results

As shown in **Fig. 1**, the most common bacterial species detected by PCR was *H. influenzae* (n = 19, 13.4%), followed by *S. pneumoniae* (n = 18, 12.7%), *B. pertussis* (n = 7, 4.9%), *M. pneumoniae* (n = 3, 2.1%), *L. pneumophilia* (n = 2, 1.4%), and *C. pneumoniae* (n = 1, 0.7%). Nine patients were positive for 2 concurrent species as follows: *S. pneumoniae* and *B. pertussis* (n = 5, 3.5%), *L. pneumophilia* and *H. influenzae* (n = 1, 0.7%), *L. pneumophilia* and *B. pertussis* (n = 1, 0.7%), *M. pneumoniae* and *S. pneumoniae* (n = 1, 0.7%), and *H. influenzae* and *B. pertussis* (n = 1, 0.7%).

Positive PCR for *B. pertussis*

Subgroup analysis for *B. pertussis* (**Supplementary Tables S1** and **S2**) showed that there was no difference in clinical symptoms of pertussis according to the positivity for *B. pertussis*. Those with positive PCR for *B. pertussis* had more sneezing at the time of cough onset than those without positive PCR for *B. pertussis* ($P = 0.020$).

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Table 1. Baseline characteristics of the study population according to the multiplex bacterial PCR results

Characteristics	Total (N = 142)	Negative PCR (n = 101)	Positive PCR (n = 41)	*P* value*
Age (year)	40.0 (33.0–56.5)	43.0 (35.0–57.0)	37.0 (30.0–54.0)	0.134
Sex				> 0.999
Female	102 (71.8)	73 (72.3)	29 (70.7)	
Male	40 (28.2)	28 (27.7)	12 (29.3)	
BMI (kg/m^2)	22.8 ± 3.0	23.1 ± 3.0	22.1 ± 3.0	0.075
Smoking history				0.558
Never-smoker	110 (77.5)	79 (78.2)	31 (75.6)	
Ex-smoker	17 (12.0)	13 (12.9)	4 (9.8)	
Current smoker	15 (10.6)	9 (8.9)	6 (14.6)	
Smoking amount (pack-years)	4.0 (1.5–11.0)	3.8 (1.0–20.0)	7.0 (2.0–10.2)	0.863
Diagnosed medical history				
Allergic sensitization	20 (14.1)	16 (15.8)	4 (9.8)	0.359
Allergic rhinitis	33 (23.2)	24 (23.8)	9 (22.0)	0.629
GERD	51 (35.9)	39 (38.6)	12 (29.3)	0.551
Pulmonary TB	9 (6.3)	7 (6.9)	2 (4.9)	0.775
Comorbidity in current treatment				
Allergic rhinitis	11 (7.7)	8 (7.9)	3 (7.3)	0.991
GERD	4 (2.8)	3 (3.0)	1 (2.4)	0.862
Taking antibiotics day after the onset of coughing	75 (52.8)	55 (54.5)	20 (48.8)	0.486
Pertussis vaccination within 10 year	4 (2.8)	2 (2.0)	2 (4.9)	0.451

Values are presented as numbers (%) for categorical variables and median (interquartile ranges) or mean ± standard deviation according to their normality for continuous variables.
PCR, polymerase chain reaction; BMI, body mass index; GERD, gastroesophageal reflux; TB, tuberculosis.
*P values for categorical variables were calculated with the χ^2 test; P values for continuous variables were estimated with the t-test or Mann-Whitney U test.

PCR positivity according to smoking status

Fig. 2 and **Supplementary Table S3** show positive PCR rates for bacteria according to smoking status. The analysis showed that the dual positive PCR rate for bacteria is higher in smokers than in ex-smokers or never-smokers ($P < 0.001$). The current smokers had a higher rate of symptoms including whooping ($P = 0.007$) and fever ($P = 0.033$) and PCR positivity for *H. influenzae* ($P = 0.032$) compared to ex-smokers or never-smokers.

DISCUSSION

The present study evaluated bacterial detection in the nasal swabs of patients with postinfectious subacute cough. Of 142 patients, 41 (28.9%) showed bacterial positivity on PCR. The most common species detected by bacterial PCR was *H. influenzae* (n = 19), followed by *S. pneumoniae* (n = 18), *B. pertussis* (n = 7), *M. pneumoniae* (n = 3), *L. pneumophilia* (n = 2), and *C. pneumoniae* (n = 1). In our study, 1 in 20 subjects with subacute cough showed bacterial positivity for PCR for *B. pertussis.*

According to the current guidelines, postinfectious subacute cough can be diagnosed in patients with cough persisting for 3 to 8 weeks after improvement of acute symptoms of respiratory infection, and cough caused by other disease entities is excluded. Thus, the evaluation of microorganisms is not routinely recommended. Accordingly, although the postinfectious cough is one of the most common causes of subacute cough, little is known about the microorganisms associated with postinfectious subacute cough. Bacterial infection, especially by *B. pertussis*, might benefit from antibiotic administration in terms of cough treatment as well as containing the spread of *B. pertussis*. While studies evaluating these issues have clinical relevance, few have evaluated the bacterial etiology of subacute cough, necessitating this study.

Table 2. Comparison of symptoms between patients with positive and negative PCR results

Characteristics	Total (N = 142)	Negative PCR (n = 101)	Positive PCR (n = 41)	*P* value*
Duration of cough at the time of OPD visit				
Cough duration (day)	29 (23–35)	28 (24–33)	29 (22–40)	0.191
Cough duration > 4 week	72 (50.7)	49 (48.5)	23 (56.1)	0.526
The total duration of the cough†	(n = 102)	(n = 74)	(n = 28)	
Cough duration (day)	48 (35–70)	46 (35–64)	56 (35–74)	0.337
Cough duration > 8 week	38 (37.3)	24 (32.4)	14 (50.0)	0.159
Associated symptoms at the time of cough onset				
Fever or feverish	44 (31.0)	30 (29.7)	14 (34.1)	0.330
Chill	42 (29.6)	29 (28.7)	13 (31.7)	0.738
Myalgia	73 (51.4)	49 (48.5)	24 (58.5)	0.541
Rhinorrhea	85 (59.9)	58 (57.4)	27 (65.9)	0.612
Nasal congestion	66 (46.5)	43 (42.6)	23 (56.1)	0.168
Sneezing	76 (53.5)	55 (54.5)	21 (51.2)	0.629
Sputum production	102 (71.8)	68 (67.3)	34 (82.9)	0.101
Sore throat	85 (59.9)	60 (59.4)	25 (61.0)	0.569
Chest pain	45 (31.7)	28 (27.7)	17 (41.5)	0.147
Dyspnea	28 (19.7)	17 (16.8)	11 (26.8)	0.127
Any associated symptoms at the time of cough onset	137 (96.5)	98 (97.0)	39 (95.1)	0.626
Associated symptoms at the time of OPD visit				
Fever or feverish	15 (10.6)	12 (11.9)	3 (7.3)	0.640
Chill	11 (7.7)	9 (8.9)	2 (4.9)	0.463
Myalgia	23 (16.2)	15 (14.9)	8 (19.5)	0.654
Rhinorrhea	47 (33.1)	30 (29.7)	17 (41.5)	0.402
Nasal congestion	34 (23.9)	21 (20.8)	13 (31.7)	0.370
Sneezing	42 (29.6)	32 (31.7)	10 (24.4)	0.686
Sputum production	99 (69.7)	67 (66.3)	32 (78.0)	0.275
Sore throat	48 (33.8)	38 (37.6)	10 (24.4)	0.257
Chest pain	40 (28.2)	28 (27.7)	12 (29.3)	0.102
Dyspnea	27 (19.0)	21 (20.8)	6 (14.6)	0.578
Any associated symptoms at the time of OPD visit	124 (87.3)	86 (85.1)	38 (92.7)	0.345
Severity of cough				
Cough visual analogue scale	6.0 (4.0–7.3)	6.2 (4.0–7.4)	5.7 (3.0–7.1)	0.329
Cough Symptom Score in daytime	3.0 (3.0–4.0)	3.0 (3.0–4.0)	3.0 (3.0–4.0)	0.724
Cough Symptom Score in nighttime	2.0 (1.0–3.0)	2.0 (1.0–2.5)	2.0 (1.0–3.0)	0.335
LCQ total score	11.6 ± 3.3	11.7 ± 3.3	11.3 ± 3.2	0.573

Values are presented as numbers (%) for categorical variables and median (interquartile range) or mean ± standard deviation according to their normality for continuous variables.
PCR, polymerase chain reaction; OPD, outpatient; LCQ, Leicester Cough Questionnaire.
*P values for categorical variables were calculated with the χ^2 test; P values for continuous variables were estimated with the t-test or Mann- Whitney U test.
†The total duration of the cough was determined when the patients had no cough without any cough medication.

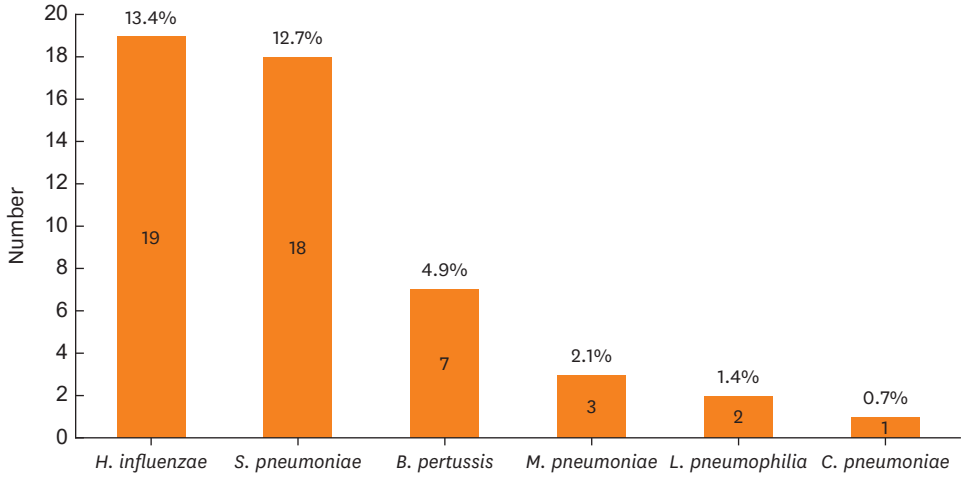


Fig. 1. Positive polymerase chain reaction rate by type of bacteria.

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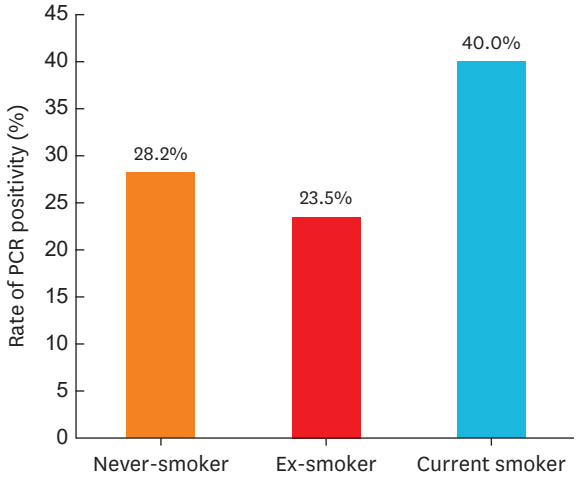


Fig. 2. Positive PCR rate by smoking status.
PCR, polymerase chain reaction.

Among patients with postinfectious cough, about one-third were positive for bacterial PCR. The common etiologies were *H. influenzae*, *S. pneumoniae*, and *B. pertussis*.[14] Interestingly, previous studies that evaluated PCR results in patients with protracted cough showed *M. pneumoniae*, *C. pneumoniae*, *H. influenzae*, and *S. pneumoniae* as common etiologies,[14,15] which is consistent with our study results. As antibiotics are considered effective in patients with protracted cough,[16] they will also be helpful in patients with postinfectious cough showing positive PCR for bacterial infection. The other notable finding of our study is that some patients can be positive for more than one bacterial species. However, as our study did not evaluate the clinical applicability of our results, future studies are needed to determine clinical usefulness, especially surrounding the treatment efficacy of antibiotics in patients with positive PCR results.

B. pertussis is a well-known bacterium causing subacute cough.[17] Although *B. pertussis* is a known pathogen, vaccinated patients can present with milder symptoms without the typical sign of whooping cough. Thus, if bacterial tests are not considered, diagnosis and proper treatment of this disease entity would be difficult. Also, pertussis is highly contagious. In this view, our study provides valuable information regarding the rate of positive PCR results for *B. pertussis* and clinical characteristics in patients with positive PCR for *B. pertussis* in Korea. Interestingly, the rate of positive PCR results for *B. pertussis* was relatively low (about 5%). A previous multicenter study of the largest number of subjects in Korea showed that the positive PCR rate for *B. pertussis* in subjects who had coughed for more than 2 weeks was 0.5% in the period from 2009 to 2011.[10] Similarly, another study in Korea reported that the positive PCR rate for *B. pertussis* was 0.7%.[18] However, 2 other studies reported PCR rates for *B. pertussis* of 2.9% and 6.9%, respectively.[19,20] In addition, comorbidities could increase the risk for pertussis.[21] Despite the variable positive PCR rate for *B. pertussis*, the incidence rate of pertussis in Korea has been increasing over the past 2 decades.[22] Therefore, the positive rate of this study for *B. pertussis* was comparable to the previous studies despite excluding airway and pulmonary diseases.

Unexpectedly, we have found that the dual positive PCR rate for bacteria was higher in current smokers than in never- or ex-smokers. However, considering smoking is a well-known factor for increased risk of upper respiratory infection,[23] which is the main cause of

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subacute cough, our findings are not surprising. Clinically, our study results may suggest that a bacterial PCR test is more helpful for the diagnosis of infectious etiology in smokers compared to never- or ever-smokers. However, since our study was not performed for this subject, well-designed future studies are needed.

There are several limitations to our study. First, this study was performed in referred centers in Korea; therefore, the generalization of our findings may be limited. Secondly, we did not evaluate viral PCR in patients with postinfectious cough. However, the main purpose of our study was to evaluate bacterial PCR, including *B. pertussis*. Thirdly, positive PCR for some bacteria may be caused by colonization. However, as we included patients with a high likelihood of postinfectious cough, the false-positive rate may be low. Finally, the causative agent of bacterial infection could be affected by the recently used antibiotics. However, there was no significant difference in the rate of taking antibiotics between the 2 groups according to the PCR positivity. Although we aimed to include patients with subacute cough, some patients continued to cough for more than 8 weeks, which can be defined as chronic cough. However, considering the prospective design of our study, we had to define subacute cough based on the cough duration before outpatient department visit.

In conclusion, about one-third of patients with suspected subacute infectious cough were positive for bacterial PCR in nasal swabs. The positive PCR rate for *B. pertussis* was 5%. Our study indicates that PCR may be helpful to identify underlying etiologies in patients with subacute postinfectious cough.

ACKNOWLEDGMENTS

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SUPPLEMENTARY MATERIALS

Supplementary Table S1

Characteristics of the study population according to the PCR positivity

Click here to view

Supplementary Table S2

Characteristics of the study population according to the PCR positivity of *Bordetella Pertussis*

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Supplementary Table S3

Positivity of the PCR according to smoking status

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REFERENCES

1. Cho SH, Lin HC, Ghoshal AG, Bin Abdul Muttalif AR, Thanaviratananich S, Bagga S, et al. Respiratory disease in the Asia-Pacific region: cough as a key symptom. Allergy Asthma Proc 2016;37:131-40.
PUBMED | CROSSREF
2. Song DJ, Song WJ, Kwon JW, Kim GW, Kim MA, Kim MY, et al. KAAACI evidence-based clinical practice guidelines for chronic cough in adults and children in Korea. Allergy Asthma Immunol Res 2018;10:591-613.
PUBMED | CROSSREF
3. Joo H, Moon JY, An TJ, Choi H, Park SY, Yoo H, et al. Revised Korean cough guidelines, 2020: recommendations and summary statements. Tuberc Respir Dis 2021;84:263-73.
PUBMED | CROSSREF
4. Kwon NH, Oh MJ, Min TH, Lee BJ, Choi DC. Causes and clinical features of subacute cough. Chest 2006;129:1142-7.
PUBMED | CROSSREF
5. Won HK, Kang SY, Kang Y, An J, Lee JH, Lee SM, et al. Cough-related laryngeal sensations and triggers in adults with chronic cough: symptom profile and impact. Allergy Asthma Immunol Res 2019;11:622-31.
PUBMED | CROSSREF
6. Song WJ, Chang YS, Faruqi S, Kim JY, Kang MG, Kim S, et al. The global epidemiology of chronic cough in adults: a systematic review and meta-analysis. Eur Respir J 2015;45:1479-81.
PUBMED | CROSSREF
7. An TJ, Kim JW, Choi EY, Jang SH, Lee HY, Kang HS, et al. Clinical characteristics of chronic cough in Korea. Tuberc Respir Dis 2020;83:31-41.
PUBMED | CROSSREF
8. Braman SS. Postinfectious cough: ACCP evidence-based clinical practice guidelines. Chest 2006;129:138S-46S.
PUBMED | CROSSREF
9. Mungall BA, Kim H, Oh KB. A systematic review of the burden of pertussis in South Korea. Hum Vaccin Immunother 2021;17:1747-56.
PUBMED | CROSSREF
10. Park S, Lee MG, Lee KH, Park YB, Yoo KH, Park JW, et al. A multicenter study of pertussis infection in adults with coughing in Korea: PCR-based study. Tuberc Respir Dis 2012;73:266-72.
PUBMED | CROSSREF
11. Birkebaek NH, Kristiansen M, Seefeldt T, Degn J, Moller A, Heron I, et al. Bordetella pertussis and chronic cough in adults. Clin Infect Dis 1999;29:1239-42.
PUBMED | CROSSREF
12. Kwon JW, Moon JY, Kim SH, Song WJ, Kim MH, Kang MG, et al. Korean version of the Cough Symptom Score: clinical utility and validity for chronic cough. Korean J Intern Med 2017;32:910-5.
PUBMED | CROSSREF
13. Kwon JW, Moon JY, Kim SH, Song WJ, Kim MH, Kang MG, et al. Reliability and validity of a Korean version of the Leicester Cough Questionnaire. Allergy Asthma Immunol Res 2015;7:230-3.
PUBMED | CROSSREF
14. Yuan X, Liu Y, Bai C, Luo Y, Wang R, Wang R, et al. Mycoplasma pneumoniae infection is associated with subacute cough. Eur Respir J 2014;43:1178-81.
PUBMED | CROSSREF
15. Hare KM, Marsh RL, Smith-Vaughan HC, Bauert P, Chang AB. Respiratory bacterial culture from two sequential bronchoalveolar lavages of the same lobe in children with chronic cough. J Med Microbiol 2015;64:1353-60.
PUBMED | CROSSREF
16. Lai K, Shen H, Zhou X, Qiu Z, Cai S, Huang K, et al. Clinical practice guidelines for diagnosis and management of cough—Chinese Thoracic Society (CTS) asthma consortium. J Thorac Dis 2018;10:6314-51.
PUBMED | CROSSREF
17. Irwin RS, French CL, Chang AB, Altman KW; CHEST Expert Cough Panel. Classification of cough as a symptom in adults and management algorithms: CHEST guideline and expert panel report. Chest 2018;153:196-209.
PUBMED | CROSSREF
18. Park S, Oh KC, Kim KS, Song KT, Yoo KH, Shim YS, et al. Role of atypical pathogens and the antibiotic prescription pattern in acute bronchitis: a multicenter study in Korea. J Korean Med Sci 2015;30:1446-52.
PUBMED | CROSSREF

19. Park WB, Park SW, Kim HB, Kim EC, Oh M, Choe KW. Pertussis in adults with persistent cough in South Korea. Eur J Clin Microbiol Infect Dis 2005;24:156-8.
PUBMED | CROSSREF

20. Park S, Lee SH, Seo KH, Shin KC, Park YB, Lee MG, et al. Epidemiological aspects of pertussis among adults and adolescents in a Korean outpatient setting: a multicenter, PCR-based study. J Korean Med Sci 2014;29:1232-9.
PUBMED | CROSSREF

21. Kim H, Shin JY, Chen J, Kim JH, Noh Y, Cheong HJ, et al. Risk factors of pertussis among older adults in South Korea: a nationwide health data-based case-control study. Infect Dis Ther 2023;12:545-61.
PUBMED | CROSSREF

22. Kim C, Yi S, Cho SI. Recent increase in pertussis incidence in Korea: an age-period-cohort analysis. Epidemiol Health 2021;43:e2021053.
PUBMED | CROSSREF

23. Jiang C, Chen Q, Xie M. Smoking increases the risk of infectious diseases: a narrative review. Tob Induc Dis 2020;18:60.
PUBMED | CROSSREF