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Radiological findings in acute *Haemophilus influenzae* pulmonary infection

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Objective: The aim of this study was to assess pulmonary thin-section CT findings in patients with acute *Haemophilus influenzae* pulmonary infection.
Methods: Thin-section CT scans obtained between January 2004 and March 2009 from 434 patients with acute *H. influenzae* pulmonary infection were retrospectively evaluated. Patients with concurrent infection diseases, including *Streptococcus pneumoniae* ($n=76$), *Staphylococcus aureus* ($n=58$) or multiple pathogens ($n=89$) were excluded from this study. Thus, our study group comprised 211 patients (106 men, 105 women; age range, 16–91 years, mean, 63.9 years). Underlying diseases included cardiac disease ($n=35$), pulmonary emphysema ($n=23$), post-operative status for malignancy ($n=20$) and bronchial asthma ($n=15$). Frequencies of CT patterns and disease distribution of parenchymal abnormalities, lymph node enlargement and pleural effusion were assessed by thin-section CT.
Results: The CT findings in patients with *H. influenzae* pulmonary infection consisted mainly of ground-glass opacity ($n=185$), bronchial wall thickening ($n=181$), centrilobular nodules ($n=137$) and consolidation ($n=112$). These abnormalities were predominantly seen in the peripheral lung parenchyma ($n=108$). Pleural effusion was found in 22 patients. Two patients had mediastinal lymph node enlargement.
Conclusion: These findings in elderly patients with smoking habits or cardiac disease may be characteristic CT findings of *H. influenzae* pulmonary infection.

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Haemophilus influenzae is an important pneumonia pathogen because of its severity, high incidence of complications and high mortality. This Gram-negative bacillus frequently colonises the human upper respiratory tract, especially the nasopharynx, and is considered to form part of the normal respiratory flora [1]. Most *H. influenzae* infections are the result of direct extension from the nasopharynx to the lower respiratory tract [1].

H. influenzae infection has received increasing attention because it is an important factor in the acute exacerbation of chronic obstructive pulmonary disease (COPD) [1, 2]. Acute exacerbation is a frequent event during the prolonged chronic course of COPD, which entails significant morbidity and mortality, and the main aetiology for the majority of episodes is infection.

The mortality rate in patients with *H. influenzae* pneumonia has been reported as 10–42% [3–6]. Moreover, nosocomial outbreaks caused by *H. influenzae* have been reported [7]. Therefore, it is important to identify the risk factors associated with *H. influenzae* infection and to evaluate the radiological findings so that no time is lost in initiating appropriate management.

Several studies have presented the clinical and microbiological findings in patients with *H. influenzae* infection [1–4, 6, 7]. The characteristics of *H. influenzae* pneumonia on plain radiography have also been described previously [1, 8]. Recently, Nei et al [8] have described CT findings of *Mycoplasma pneumoniae* pneumonia and community-acquired pneumonia caused by other organisms, including 12 patients with *H. influenzae* pneumonia. The CT finding of bronchial wall thickening in patients with *H. influenzae* pneumonia was more common than in patients with *Streptococcus pneumoniae* or *Klebsiella pneumoniae*.

However, to the best of our knowledge, no other English-language studies of pulmonary CT findings in patients with acute *H. influenzae* pneumonia have been published. This study aimed to assess the clinical findings and pulmonary thin-section CT findings in patients with acute *H. influenzae* pneumonia.

Methods and materials

Our institutional review board approved this retrospective study and waived informed consent.

Based on the patient populations from four institutions, we retrospectively identified 434 patients with acute pulmonary infections due solely to *H. influenzae* who had undergone chest thin-section CT scans between January 2004 and March 2009. We excluded 76 patients with *S. pneumoniae*, 58 with *Staphylococcus aureus*, 33 with methicillin-resistant *S. aureus* (MRSA), 31 with *Moraxella catarrhalis*, 22 with *Pseudomonas aeruginosa*, 6 with *K. pneumoniae* and some with other pathogens who were

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diagnosed with concurrent infectious diseases by serological tests and clinical findings. Moreover, seven patients with acute *H. influenzae* pulmonary infection were excluded because of poor image quality caused by motion artefacts, inadequate window level settings or for whom hard copies of the CT film had been destroyed. Thus, the study group comprised 211 patients (106 men, 105 women; age range, 16–91 years, mean, 63.9 years) with acute *H. influenzae* pulmonary infection.

The diagnosis was established by isolation of *H. influenzae* from sputum in 170 patients, sputum from the trachea in 24 patients and bronchoalveolar lavage fluid in 17. In 90 patients at 1 of our institutions, biotypes were examined, which consisted of Type I (n=3), Type II (n=41), Type III (n=44), Type IV (n=0), Type V (n=1), Type VI (n=1) and Type VII (n=0). A patient was considered to have community-acquired pneumonia if, at the time of hospital admission, he/she presented with cough, with or without sputum, fever, leukocytosis or leukopenia, and had pulmonary infiltrates on chest radiographs. Among the 211 patients, 102 had community-acquired and 109 had nosocomial infections.

Patients with frequent various underlying disease, alcoholics and smokers were evaluated. For the purposes of this study, an alcoholic was defined as an individual with a daily consumption of ⩾80 g of alcohol during the past 2 years [9], and a patient was considered to be a heavy smoker if he/she had smoked for more than 10 pack-years.

CT examinations

Thin-section CT examinations were performed with a variety of scanners, with 1-mm collimation (n=19) at 10 mm intervals from the apex of the lung to the diaphragm, or volumetrically with a multidetector CT scanner (n=192) with 1-mm reconstruction. The scans were obtained with the patient in the supine position at full inspiration and were reconstructed using a high spatial frequency algorithm.

Images were captured at window settings that allowed viewing of the lung parenchyma (window level, −600 to −700 HU; window width, 1200–1500 HU) and the mediastinum (window level, 20–40 HU; window width, 400 HU).

The pulmonary CT scan was performed within 1–6 days (mean, 4.8 days) after the onset of respiratory symptoms. Intravenously administered contrast material was used in 10 patients.

CT image interpretation

Two chest radiologists (with 21 and 13 years of experience in chest CT image interpretation), who were aware of the underlying diagnoses, retrospectively and independently interpreted the CT scans. Conclusions were reached by consensus. On average, 2 sessions per week were reserved to review the CT scans, with a total of approximately 50 sessions.

CT images were assessed for the following radiological features: ground-glass opacity, consolidation, nodule, centrilobular nodules, bronchial wall thickening, interlobular septal thickening, intralobular reticular opacity, bronchiectasis, enlarged hilar/mediastinal lymph node(s) (>1 cm diameter short axis) and pleural effusion. Areas of ground-glass opacity were defined as hazy increases in opacity without obscured vascular markings [10, 11]. Areas of consolidation were defined as areas of increased opacity that obscured normal lung markings [10, 11]. Centrilobular nodules were defined as those present around the peripheral pulmonary arterial branches or 3–5 mm from the pleura, interlobular septa or pulmonary veins. Interlobular septal thickening was defined as abnormal widening of the interlobular septa [11]. Intralobular reticular opacity was considered present when interlacing line shadows were separated by a few millimetres [10, 11]. In addition, the frequency of the combination of each CT finding was evaluated.

The distribution of parenchymal disease was also noted. We also assessed whether the abnormal findings were located unilaterally or bilaterally. If the main lesion was predominantly located in the inner third of the lung, the disease was classified as having a central distribution. On the other hand, if the lesion was predominantly located in the outer third of the lung, the disease was classified as having a peripheral distribution. If the lesions showed no predominant distribution, the disease was classified as having a random distribution. In addition, zonal predominance was classified as upper, lower or random. Upper lung zone predominance was defined as the presence of most abnormalities at a level above the tracheal carina, while lower zone predominance was defined as most abnormalities being below the upper zone. When abnormalities showed no definite zonal predominance, the lung disease was considered to have a random distribution.

Follow-up CT examinations were performed 4 days to 2 months after antibiotic therapy in 39 patients, and follow-up chest radiographs were performed 1 day to 2 months after antibiotic therapy in 128 patients. These follow-up CT images and radiographs were also assessed.

Results

Patients' background

The underlying conditions of all patients are summarised in Table 1. Overall, 43 patients were chronic smokers, 20 were alcoholics and 15 were both alcoholics and chronic smokers. 35 patients had concomitant cardiac disease (16.6%). Patients with pulmonary emphysema (n=23, 10.9%), post-operative malignancy (n=20, 9.5%), bronchial asthma (n=15, 7.1%), diabetes mellitus (n=9, 4.3%) or liver disorders (n=8, 3.8%) were included in the study.

10 of 102 patients with community-acquired and 15 of 109 patients with nosocomial infections were treated with antibiotic therapy prior to CT examination. However, most of the patients in the present study, including the patients who received antibiotic therapy prior to CT examinations, showed rapid progression of their respiratory symptoms. The most common presenting symptoms were cough (190 patients, 90.0%), sputum (166 patients, 78.7%), fever (139 patients, 65.9%) and dyspnoea (28 patients, 13.3%).

Table 1. Patient characteristics and underlying conditions

Sex, M/F	*n* (%)
Smoking habit	43 (20.4)
Cardiac disease	35 (16.6)
Pulmonary emphysema	23 (10.9)
Alcoholic	20 (9.5)
Asthma	15 (7.1)
Diabetes mellitus	9 (4.3)
Liver disorder	8 (3.8)
Collagen disease	5 (2.4)
Malignancy	20 (9.5)
Lung cancer	3 (1.4)
Gastric cancer	2 (0.9)
Oesophageal cancer	4 (1.9)
Colon cancer	2 (0.9)
Laryngopharyngeal cancer	2 (0.9)
Presenting symptoms	
Productive cough	184 (87.2)
Non-productive cough	24 (11.4)
Fever	139 (65.9)
Dyspnoea	28 (13.3)
General weakness	26 (12.3)

CT patterns

Chest CT scans revealed abnormalities in all patients with *H. influenzae* pulmonary infection (Table 2). Among the 211 patients, ground-glass opacity (n=185, 87.7%) (Figures 1–4) was the most frequently observed abnormality, followed by bronchial wall thickening (n=181, 85.8%; Figures 1–4), centrilobular nodules (n=137, 64.9%; Figures 1, 2 and 4), consolidation (n=112, 53.1%; Figures 2 and 3) and bronchiectasis (n=34, 16.1%; Figure 3). Nodules (n=30, 14.2%), intralobular reticular opacity (n=21, 10.0%) and interlobular septal thickening (n=21, 10.0%) were also observed. The most frequently observed combination of abnormalities was ground-glass opacity and bronchial wall thickening (n=161, 76.3%; Figures 1–4), followed by ground-glass opacity and centrilobular nodules (n=135, 64.0%; Figures 1, 2 and 4), and bronchial wall thickening and centrilobular nodules (n=133, 63.0%; Figures 1, 2 and 4).

Disease distribution

Of the 211 patients with *H. influenzae* infection, abnormal findings were found bilaterally in 123 (58.3%), unilaterally in 88 (41.7%) and peripherally in 108 (51.2%; Figures 1, 2, and 4). On the other hand, 103 patients showed a random distribution (48.8%; Figure 3) and no patients had a predominantly central distribution. The predominant

Table 2. Thoracic CT findings in 211 patients

Findings	*n* (%)
Ground-glass attenuation	185 (87.7)
Bronchial wall thickening	181 (85.8)
Centrilobular nodules	137 (64.9)
Consolidation	112 (53.1)
Bronchiectasis	34 (16.1)
Nodules	30 (14.2)
Intralobular reticular opacity	21 (10.0)
Interlobular septal thickening	21 (10.0)
Cavity	0 (0)
Pleural effusion	22 (10.4)
Lymph node enlargement	2 (0.9)

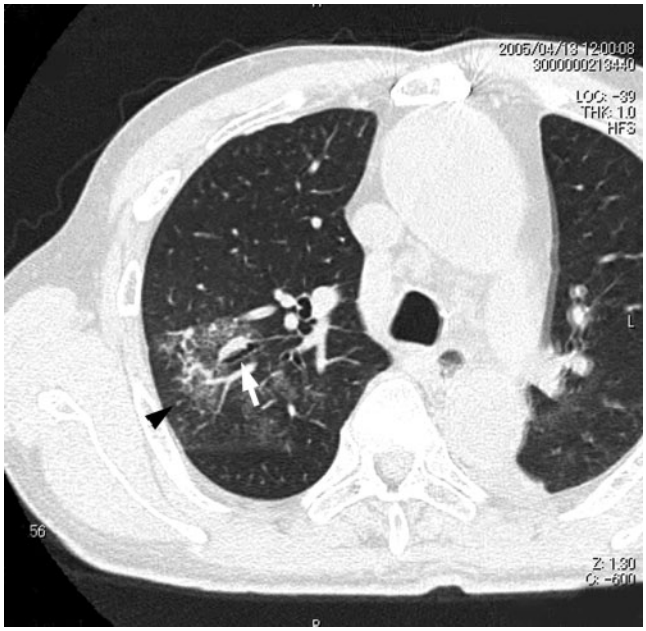

Figure 1. Acute *Haemophilus influenzae* infection in a 70-year-old woman with cardiac disease at 4 days after onset of fever and cough. A transverse thin-section CT of the right upper lobe shows ground-glass opacity, bronchial wall thickening (arrow) and centrilobular nodules (arrowhead).

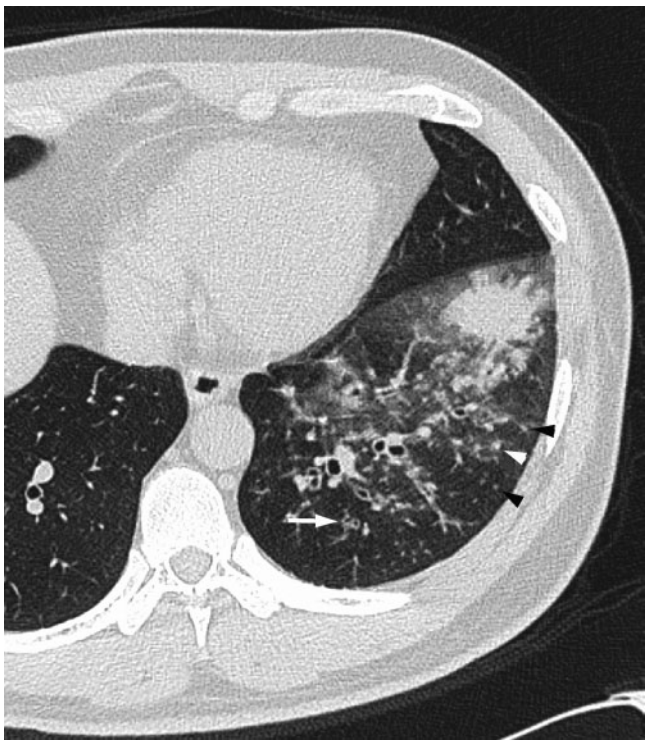

Figure 2. Acute *Haemophilus influenzae* infection in a 55-year-old man with a smoking habit at 3 days after onset of fever and cough. A transverse thin-section CT of the left lower lobe shows consolidation, ground-glass opacity, bronchial wall thickening (arrow) and centrilobular nodules (arrowheads).

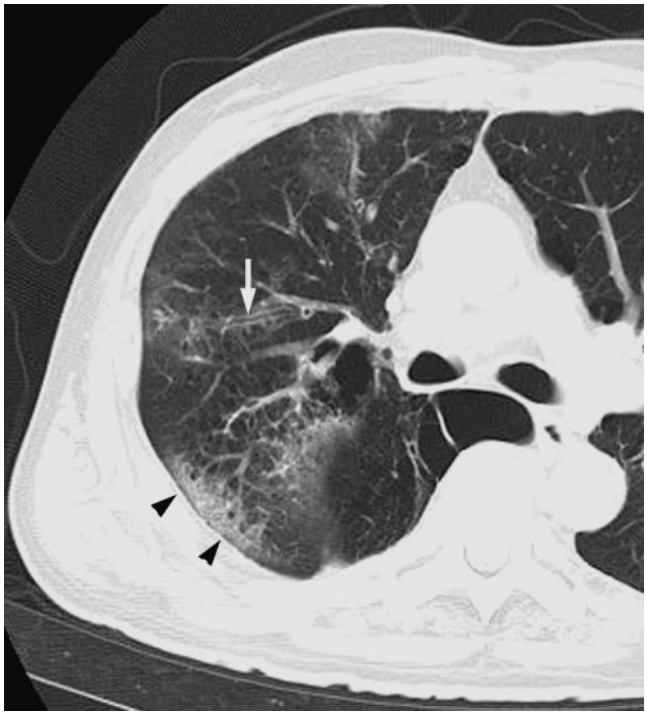

Figure 3. Acute *Haemophilus influenzae* infection in a 74-year-old alcoholic man with pulmonary emphysema at 3 days after onset of fever, cough and dyspnoea. A transverse thin-section CT 2 cm below the tracheal carina shows ground-glass opacity, bronchial wall thickening (arrow) and consolidation (arrowheads).

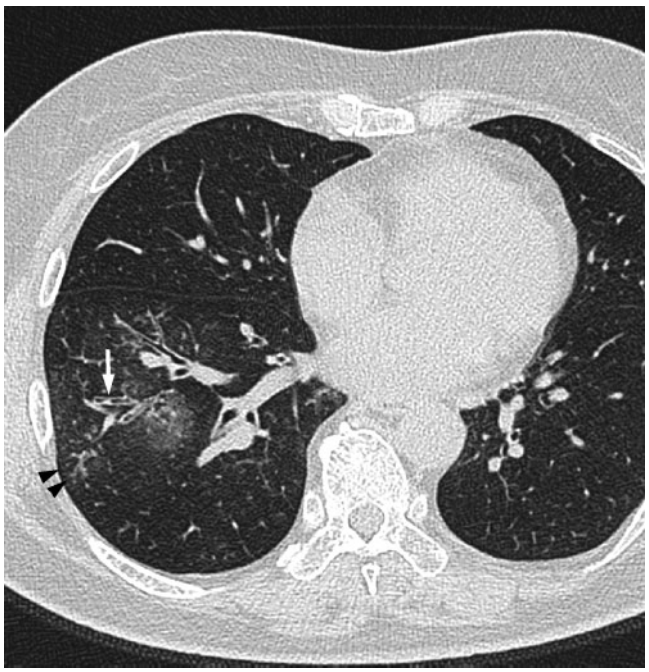

Figure 4. Acute *Haemophilus influenzae* infection in a 64-year-old man at 3 days after the onset of cough with sputum. A transverse thin-section CT of the right lower lobe shows ground-glass opacity, bronchial wall thickening (arrow) and centrilobular nodules (arrowheads).

zonal distribution of infection was the upper zone in 33 patients (15.6%; Figure 1), the lower zone in 76 patients (36.0%; Figures 2 and 4) and a random distribution in 102 patients (48.3%; Figure 3).

Effusion and lymph nodes

Bilateral pleural effusions were found in 5 patients (2.4%), and unilateral pleural effusion was found in 17 patients (8.1%) (Figure 2) with acute *H. influenzae* pulmonary infection. Two patients (0.9%) had mediastinal lymph node enlargement.

Follow-up study

All 211 patients underwent antibiotic therapy. In 99 of 102 patients with community-acquired infections (97.1%), the initial respiratory symptoms improved and the abnormal findings improved on follow-up CT examinations or chest radiographs. However, in the remaining three patients (2.9%) with pulmonary emphysema and cardiac disease, abnormal findings such as ground-glass opacity and consolidation worsened on follow-up CT and these patients subsequently died. By comparison, in 101 of 109 patients with nosocomial infections (92.7%), the initial respiratory symptoms improved and the abnormal findings improved on follow-up CT or radiographs. In the remaining eight patients (7.3%), the abnormal parenchymal findings and pleural effusions worsened and the patients subsequently died. Of these patients, four had pulmonary emphysema, one had bronchial asthma and post-operative laryngeal cancer, one had bronchial asthma with cardiac disease, one was an alcoholic with diabetes mellitus and one had cardiac disease and diabetes mellitus.

Discussion

H. influenzae is one of the most clinically important Gram-negative bacterial pathogens, and is of great concern worldwide because infections can (1) exacerbate COPD, (2) cause pneumonia, particularly in older adults and (3) consist of a nosocomial respiratory tract pathogen [1, 12, 13].

Exacerbation of COPD can be caused by many factors, including environmental irritants, heart failure or non-compliance with medication use [14]. However, most exacerbations are due to bacterial infection or viral infection [15]. Bacterial infection is a factor in 70–75% of exacerbations, with up to 60% caused by *H. influenzae*, *S. pneumoniae* or *M. catarrhalis* [2].

In addition, *H. influenzae* is the most common organism found in patients with acute exacerbation of chronic bronchitis and the second most common cause of community-acquired pneumonia in adults [16]; in addition, it is a nosocomial respiratory tract pathogen, mainly in elderly patients and those with underlying disease.

Underlying disease is found in 69–90% of adults with *H. influenzae* disease [1, 4, 17–20]. Deulofeu et al [4] have reported that 30 of 43 patients (69.8%) with *H. influenzae* disease had underlying conditions, including malignancy

(n=12, 27.9%), alcoholism (n=10, 23.3%), COPD (n=9, 20.9%) and diabetes mellitus (n=8, 18.6%). Kofteridis et al [1] have reported that the underlying diseases in 45 patients with *H. influenzae* respiratory tract infection consisted mainly of COPD (n=28, 62.2%), followed by cardiovascular diseases (n=16, 35.6%), alcoholism (n=16, 35.6%) and diabetes mellitus (n=13, 28.9%). In our study, the underlying diseases in 211 patients were mainly a smoking habit (n=43, 20.4%), cardiac disease (n=35, 16.6%), pulmonary emphysema (n=23, 10.9%), alcoholism (n=20, 9.5%) and bronchial asthma (n=15, 7.1%). In the present study, the frequencies of underlying diseases were lower than those described in previous reports [1, 4, 17–20]. Furthermore, in the present study, the patients diagnosed with concurrent infectious diseases (n=223, 51.4%) were excluded. Therefore, the frequencies observed in this study might be lower than in previous reports.

In the present study, with *H. influenzae* alone, the average age was 63.9 years, which is similar to that found in previous reports [1, 4]. *S. pneumoniae*, *K. pneumoniae*, *M. pneumoniae* and *Chlamydia pneumoniae* are also common pathogens involved in community-acquired or nosocomial pneumonia. The average age in patients with *H. influenzae* was similar to that in patients with *S. pneumoniae*, *K. pneumoniae* or *C. pneumoniae* pneumonia (60 years, 61.5 years and 57.7 years, respectively) [21–23]; however, the average age tended to be higher in patients with *H. influenzae* than in those with *M. pneumoniae* pneumonia (63.9 years *vs* 32–47.3 years, respectively) [8, 23, 24].

Among the 211 patients in this study, 102 had community-acquired and 109 had nosocomial infections, which are similar findings to an earlier report [25] and suggest that *H. influenzae* is both a nosocomial respiratory pathogen and a community-acquired pathogen.

Regarding the presenting symptoms, all patients in the present study had several complaints such as fever, cough and sputum. There were no differences between patients with other pneumonias [22, 23].

In the present study, the mortality rate was 5.2% (11 of 211 patients), which was lower than that found in previous reports [3–6]. To the best of our knowledge, there are no studies in which additional pathogens were evaluated in patients with *H. influenzae* pneumonia. In the present study, in 223 of 434 patients (51.4%) with acute *H. influenzae* pulmonary infection, one or more additional pathogens such as *S. pneumoniae*, *M. catarrhalis*, *S. aureus* or MRSA were found; the patients diagnosed with concurrent infectious diseases were excluded from this study. Moreover, in the present study, the frequencies of the underlying diseases were lower than those in previous reports. Therefore, the mortality rates in our patients with *H. influenzae* pulmonary infection might be lower than those in previous studies.

There are several case reports of patients with *H. influenzae* pulmonary infection [1, 8]. However, few of these reports included chest radiographs.

Kofteridis et al [1] have reported that, in 34 of 45 patients with *H. influenzae* respiratory tract infection, pneumonia was observed on chest radiographs, and in 24 of the 34 patients with *H. influenzae*, segmental opacity on chest radiographs were characteristics that were similar to those reported previously. Nei et al [8] have studied whether CT findings of *M. pneumoniae* pneumonia could be distinguished from community-acquired pneumonia caused by other organisms, including 12 patients with *H. influenzae* pneumonia. The CT findings of bronchial wall thickening in patients with *M. pneumoniae* pneumonia was significantly more common than in patients with community-acquired pneumonia; however, the CT findings were more common in community-acquired pneumonia due to *H. influenzae* than with other pathogens (*S. pneumoniae* in 20 patients, *K. pneumoniae* in 2 and *Legionella pneumophila* in 1).

However, to the best of our knowledge, no other English-language studies of pulmonary CT findings in patients with acute *H. influenzae* pulmonary infection have been published.

We retrospectively evaluated the CT findings of 211 patients with acute *H. influenzae* pulmonary infection. The most common CT finding was ground-glass opacity followed by bronchial wall thickening, centrilobular nodules, consolidation and bronchiectasis. The abnormal findings were predominantly seen in the peripheral lungs.

Nambu et al [21] reported that the CT findings in 41 patients with *S. pneumoniae* pneumonia consisted mainly of consolidation, reticular opacity and centrilobular nodules (90%, 39% and 32%, respectively). We have previously reported chest CT findings in 198 patients with acute *K. pneumoniae* pneumonia alone [22], in 42 patients with *M. pneumoniae* pneumonia alone [23] and in 40 patients with *C. pneumoniae* pneumonia alone [23]. The frequency of bronchial wall thickening associated with *H. influenzae* infection was higher than that with *S. pneumoniae*, *K. pneumoniae* or *C. pneumoniae* infections (85.8% *vs* 41%, 26.3% ($p<0.001$) and 35.0% ($p<0.001$), respectively) [21–23]. Moreover, the frequency of centrilobular nodules associated with *H. influenzae* infection was also higher than that with *S. pneumoniae*, *K. pneumoniae* or *C. pneumoniae* infections (64.9% *vs* 32%, 4.0% ($p<0.001$) and 7.5% ($p<0.001$), respectively) [21–23]. The frequencies of these features in patients with *H. influenzae* infection were similar to those seen in *M. pneumoniae* infection [23, 24]. However, *M. pneumoniae* is a well-known and common cause of atypical community-acquired pneumonia, mainly in young adults with no underlying diseases, and the average age of patients with *M. pneumoniae* infection was lower than that of patients with *H. influenzae* infection (32–36.6 years *vs* 63.9 years) [8, 24, 26]. The frequency of consolidation was lower than that with *S. pneumoniae* or *K. pneumoniae* (56.1% *vs* 90 and 91.4% ($p<0.001$), respectively) [21, 22]. In addition, intralobular reticular opacity was less frequently seen with *H. influenzae* than with *K. pneumoniae* or *C. pneumoniae* infections (10.0% *vs* 85.9% ($p<0.001$) and 70.0% ($p<0.001$), respectively) [22, 23].

Bilateral pleural effusion was seen in 5 patients (2.4%), and unilateral pleural effusion was seen in 17 patients (8.1%) with *H. influenzae* infection. The frequency of pleural effusions was lower than in patients with other pathogens such as *S. pneumoniae*, *C. pneumoniae* or *K. pneumoniae* (20%, 25–30% and 53%, respectively) [21–23].

Two patients had mediastinal lymph node enlargement in our present study. The frequency of lymph node enlargement was also lower in these patients than in patients with *S. pneumoniae*, *C. pneumoniae* or

M. pneumoniae (0.9% *vs* 36%, 5–33% and 7.1–10%, respectively) [21–24].

It should be noted that there are several limitations to our study. Firstly, this was a retrospective study and CT images were interpreted by consensus. Secondly, our study lacked a pathological correlation with specific CT findings such as consolidation and intralobular reticular opacity. Thirdly, the thin-section CT images were obtained at several institutions using different protocols. Fourthly, biotypes of *H. influenzae* were examined in only 90 patients at 1 of our institutions; moreover, serotype was not examined. However, no differences among each biotype were present on CT findings in 90 patients. As well, no differences on clinical findings were observed, which was similar to a previous report [4].

In summary, the thin-section CT manifestations in patients with *H. influenzae* pulmonary infection consisted mainly of ground-glass opacity, bronchial wall thickening and centrilobular nodules in the lung periphery, with a low frequency of pleural effusion or lymph node enlargement. These findings in elderly patients with a smoking habit, cardiac disease or pulmonary emphysema may be characteristic CT findings of *H. influenzae* pulmonary infection.

References

1. Kofteridis D, Samonis G, Mantadakis E, Maraki S, Chrysofakis G, Alegakis D, et al. Lower respiratory tract infections caused by *Haemophilus influenzae*: clinical features and predictors of outcome. Med Sci Monit 2009;15:135–9.
2. Soler N, Torres A, Ewing S, Gonzalez J, Celis R, El-Ebiary M, et al. Bronchial microbial patterns in severe exacerbations of chronic obstructive pulmonary disease (COPD) requiring mechanical ventilation. Am J Respir Crit Care Med 1998;157:1498–505.
3. Farley MM, Stephens DS, Brachman PS Jr, Harvey RC, Smith JD, Wenger JD. Invasive *Haemophilus influenzae* in adults: a prospective, population-based surveillance. Ann Intern Med 1992;116:806–12.
4. Deulofeu F, Nava JM, Bella F, Marti C, Morera MA, Font B, et al. Prospective epidemiological study of invasive *Haemophilus influenzae* disease in adults. Eur J Clin Microbiol Infect Dis 1994;13:633–8.
5. Moreno S, Martinez R, Barros C, Gonzalez-Lahoz J, Farcia-Delgado E, Bouza E. Latent *Haemophilus influenzae* pneumonia in patients with HIV. AIDS 1991;5:967–70.
6. Berk SL, Shirley A, Holtsclaw A, Wiener SL, Smith JK. Nontypeable *Haemophilus influenzae* in the elderly. Arch Intern Med 1982;142:537–9.
7. Van Dort M, Walden C, Walker ES, Reynolds SA, Levy F, Sarubi FA. An outbreak of infections caused by nontypeable *Haemophilus influenzae* in an extended care facility. J Hosp Infect 2007;66:59–64.
8. Nei T, Yamano Y, Sakai F, Kudoh S. *Mycoplasma pneumoniae* pneumonia: differential diagnosis by computerized tomography. Intern Med 2007;46:1083–7.
9. Torres A, Serra-Batlles J, Ferrer A, Jimenez P, Celis R, Cobo E, et al. Severe community-acquired pneumonia—epidemiology and prognostic factors. Am Rev Respir Dis 1991;144:312–18.
10. Webb WR, Muller NL, Naidich DP. High-resolution computed tomography findings of lung disease. In: Webb WR, Muller NL, Naidich DP, eds. High-resolution CT of the lung. 3rd edn. Philadelphia, PA: Lippincott Williams & Wilkins, 2001: 71–92.
11. Austin JH, Muller NL, Friedman PJ, Hansell DM, Naidlich DO, Remy-Jardin M, et al. Glossary of terms for CT of the lungs: recommendations of the Nomenclature Committee of the Fleischner Society. Radiology 1996;200:327–31.
12. Miller EH, Capla ES. Nosocomial Haemophilus pneumonia in patients with severe trauma. Surg Gynecol Obstet 1984; 159:153–6.
13. Simon HB, Southwick FS, Moellering RC Jr, Sherman E. *Haemophilus influenzae* in hospitalized adults: current perspectives. Am J Med 1980;69:219–26.
14. Voelkel NF, Tuder R. COPD: exacerbation. Chest 2000;117: S376–9.
15. Fein A, Fein AM. Management of acute exacerbations in chronic obstructive pulmonary disease. Curr Opin Pul Med 2006;6:122–6.
16. Moxon ER, Murphy FT. *Haemophilus influenzae*. In: Mandell GL, Douglas RG, Beet JE, eds. Principles and practice of infectious diseases. 6th edn. New York: Churchill Livingstone, 2005: 2369–78.
17. Trollfors B, Claesson B, Lagergård T, Sandberg T. Incidence, predisposing factors and manifestations of invasive *Haemophilus influenzae* infections in adults. Eur J Clin Microbiol 1984;3:180–4.
18. Granoff DM, Basden M. *Haemophilus influenzae* infections in Fresno Country, California: A prospective study of the effects of age, race, and contact with a case on incidence of disease. J Infect Dis 1980;141:40–6.
19. Takala AK, Eskola J, van Alphen L. Spectrum of invasive *Haemophilus influenzae* Type b disease in adults. Arch Intern Med 1990;150:2573–6.
20. Wallace RJ Jr, Musher DM, Septimus EJ, McGowan JE Jr, Quinones FJ, Wiss K, et al. *Haemophilus influenzae* infections in adults: Characterization of strains by serotypes, biotypes, and beta-lactamase production. J Infect Dis 1981;144:101–6.
21. Nambu A, Saito A, Araki T, Ozawa K, Hiejima Y, Akao M, et al. *Chlamydia pneumoniae*: comparison with findings of *Mycoplasma pneumoniae* and *Streptococcus pneumoniae* at thin-section CT. Radiology 2006;238:330–8.
22. Okada F, Ando Y, Honda K, Nakayama T, Kiyonaga M, Ono A, et al. Clinical and pulmonary thin-section CT findings in acute *K. pneumoniae* pneumonia. Eur Radiol 2009;19:809–15.
23. Okada F, Ando Y, Wakisaka M, Matsumoto S, Mori H. *Chlamydia pneumoniae* pneumonia and *Mycoplasma pneumoniae* pneumonia: Comparison of clinical findings and CT findings. J Comput Assist Tomogr 2005;29:626–32.
24. Reittner P, Müller NL, Heyneman L, Johkoh T, Park JS, Lee KS, et al. *Mycoplasma pneumoniae* pneumonia: Radiographic and high-resolution CT features in 28 patients. AJR Am J Roentgenol 2000;174:37–41.
25. Morrissey I, Maher K, Williams L, Shackcloth J, Felmingham D, Reynolds R; BSAC Working Parties on Resistance Surveillance. Non-susceptibility trends among *Haemophilus influenzae* and *Moraxella catarrhalis* from community-acquired respiratory tract infections in the UK and Ireland, 1999–2007. J Antimicrob Chemother 2008;62:ii97–103.
26. Atkinson TP, Balish MF, Waites KB. Epidemiology, clinical manifestations, pathogenesis and laboratory detection of *Mycoplasma pneumoniae* infections [Review]. FEMS Microbiol Rev 2008;32:956–73.