


## ORIGINAL ARTICLE

# *Eikenella corrodens* infections in human: Reports of six cases and review of literatures

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**Abstract**

**Purpose:** To investigate clinical characteristics of six cases of *Eikenella corrodens* infection in Ningbo First Hospital in China in recent 2 years.

**Methods:** We retrospectively analyze medical records of six cases of *E. corrodens* infection in Ningbo First Hospital from 2020 to 2021. And we describe the gender, age, clinical manifestations, antimicrobial administration, and treatment of the six patients.

**Results:** Five of the patients had deep infection and they were treated with surgical drainage or abscess resection plus antimicrobial administration. After treatment, five patients were discharged and recovered well, and another patient was transferred to another hospital for further treatment. All the six cases were in line with the reports on the clinical characteristics of patients infected with *E. corrodens* at home and abroad before 2021.

**Conclusion:** *Eikenella corrodens* is a part of the normal flora of human oropharynx, but it can migrate to other parts of the human body to cause severe invasive disease in humans. Although it is susceptible to most antimicrobials, it needs debridement in the treatment of deep infection.

**KEYWORDS**

clinical characteristics, *Eikenella corrodens*, infection, treatment

## 1 | INTRODUCTION

*Eikenella corrodens* is a bacterium of the HACEK group, belonging to *Eikenella* of *Neisseria* family. It is a small, non-spore-forming, facultatively anaerobic nonmotile Gram-negative rod. Under aerobic conditions, it grows slowly in blood agar or chocolate agar at 35–37°C and 5% carbon dioxide and is conducive to growth. Colonies are rough, convex, round or irregular edged, gray, translucent, and non-hemolytic.<sup>1</sup> It is a part of oropharyngeal, upper respiratory, and mucosal microbiota. It is considered to be an opportunistic pathogen

leading to various infections, mainly head and neck diseases. Most infections are mild and benign, but under special conditions, it can lead to severe invasive infections. However, there have been sporadic reports on invasive infections due to *E. corrodens*. It has been reported in the literature at home and abroad that the bacterium can cause Intra-Deltoid Abscess,<sup>2</sup> pericarditis,<sup>3</sup> brain abscess,<sup>4</sup> perirenal abscess,<sup>5</sup> head and neck infection,<sup>6</sup> liver abscess,<sup>7</sup> and hip arthritis<sup>8</sup> and can cause infection in adults and children. Based on this, we analyzed the clinical characteristics of six cases of *E. corrodens* infection in Ningbo First Hospital in China in recent 2 years.

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## 2 | CASE PRESENTATION

### 2.1 | Case 1

Patient 1, a 50-year-old male with a past history of diabetes and hypertension. There was no obvious inducement for the occurrence of posterior neck redness at home. The patient's symptoms had worsened in the past 5 days, and the range of posterior neck redness had gradually increased, accompanied by pain, fever, dizziness, headache, and vertigo. For further treatment, he was admitted to the hospital with "neck skin abscess, furuncle, and carbuncle". At admission, the ear temperature was 38.0°C and the white blood cell count and high-susceptibility C-reactive protein (h-CRP) increased. He was given piperacillin/tazobactam combined with vancomycin for infection. After excluding the contraindications of operation, under general anesthesia, the "cervical nerve entrapment and release, fascial chamber incision and decompression, and negative pressure sealing and drainage" was performed. The pus was sent for bacterial and fungal culture. Piperacillin/tazobactam intravenous fluids were continued after operation. The result of pus culture on the third day after operation was *Staphylococcus epidermidis* infection. Drug susceptibility results showed that the isolate was susceptible to moxifloxacin. Based on it, the antimicrobial administration was changed to moxifloxacin. The abscess did not improve on the 8<sup>th</sup> day after operation. Imaging examination showed that the right neck abscess was possible. The right neck abscess drained more purulent liquid by the ultrasound-guided puncture, and the liquid was sent for bacterial and fungal culture. Moxifloxacin was discontinued and the antimicrobial upgraded to vancomycin and cefoperazone/sulbactam. The result of this culture was *E. corrodens*. The effect of antimicrobial treatment was not good. Then, under general anesthesia, the patient gave consent to medical treatments, including the "cervical nerve entrapment and release, abscess incision and drainage, and chronic ulcer repair and negative pressure sealing drainage". After the operation, clindamycin combined with moxifloxacin intravenous fluids was administered to prevent inflammation and observe drainage. The postoperative recovery was acceptable, and the patient was discharged on the ninth day after the operation.

### 2.2 | Case 2

Patient 2, a 64-year-old male with a past history of lung cancer. The general condition was acceptable. CT showed the postoperative changes of the left lung and left pneumothorax. The body temperature fluctuated at 36–38.6°C, and he was treated with cefoperazone/sulbactam. On the second day after admission, the pleural effusion was drained by closed drainage. The results of pleural fluid culture showed mixed infection of *E. corrodens* and *Proteus mirabilis*. He was continued on anti-infective treatment with cefoperazone/sulbactam, but the effect was poor. Endoscopy on the seventh day after admission showed that a large number of purulent secretions were found at the left main bronchial stump. After lavage, flushing and aspiration of sputum, a fish mouth-like fistula was found at

the stump. The effect of endoscopic closure of the bronchopleural fistula was poor. Finally, the patient was transferred to another hospital for bronchial stump closure under a bronchoscope.

### 2.3 | Case 3

Patient 3, a 55-year-old female with a past history of type 2 diabetes, thyroid nodule, hepatic cyst, and uterine leiomyoma. She had cough and expectoration; the sputum was yellow. So, she went to the local hospital for treatment and was diagnosed with "pneumonia". Due to allergy to penicillin and cephalosporin, she was given moxifloxacin to fight infection and dexamethasone to treat inflammation for 3 days. At first, the body temperature reduced to normal. Later, the patient developed fever again, with a maximum temperature of 40.0°C, accompanied by chills, cough and expectoration, blood in sputum, and weakness of limbs. For further diagnosis and treatment, she was admitted to Ningbo First Hospital with "infectious fever and pulmonary pneumonia". Leukocyte count and h-CRP increased at that moment. Computer Tomography (CT) showed high-density shadow with bubble in the lower lobe of the left lung, infectious lesions. A small amount of pleural effusion was found on the left. Moxifloxacin injection had poor effect after 3 days of treatment. Combined with CT findings of left lower lobe inflammation and considering the possibility of multi-drug resistant bacteria, biapenem injection was given to fight infection. Sputum culture was taken before medication, and drug susceptibility tests were performed. On the second day after admission, lavage was performed in the left lower lobe, there was no obvious abnormality found in the right bronchus, the bronchial mucosa of the left lower lobe was swollen, the lumen of each segment was unobstructed, and the bronchial mucositis of the left lower lobe was changed. *Eikenella corrodens* was cultured from alveolar lavage fluid, and biapenem injection was continued. On the fifth day after admission, she still coughed and expectorated, complained of left chest pain, and the highest body temperature was 39.3°C. It was considered that chest pain was caused by pulmonary infection. Under the guidance of ultrasound, percutaneous puncture was performed to drain the left pleural effusion, and 200 mL of light yellow pleural effusion was led out. Lung lesions and pleural effusion improved significantly after 10 days. The patient was recovered and discharged.

### 2.4 | Case 4

Patient 4, a 55-year-old male with a past history of hypertension and gout. The right submandibular mass, about the size of broad bean, was found without obvious inducement, with tenderness, mouth opening pain, and family weight when swallowing. He was treated with aloxicillin and diosmin. The abovementioned symptoms did not improve significantly after treatment, and the pre-symptoms worsened: dizziness, headache, and slight dyspnea. The initial diagnosis was "submaxillary infection", and he was admitted to the hospital. At admission, the white blood cell count and h-CRP increased. CT

TABLE 1 General clinical data of six patients with *Eikenella corrodens* infection

Patient	1	2	3	4	5	6
Sex	Male	Male	Female	Male	Male	Male
Age	50	64	55	55	53	64
Past history	Diabetes and hypertension	Lung cancer	Type II diabetes, thyroid nodule, hepatic cyst, and uterine	Hypertension and gout	Lumbar surgery	Hypertension, type II diabetes, nasopharyngeal cancer
Recent history of dental treatment	N	N	N	N	N	N
Position	Neck	Chest	Chest	Right jaw	Postoperative wound	Brain
Specimen type	Pus	Pleural effusion	Alveolar lavage fluid	Pus	Wound secretion	Pus
Mixed infection	N	Y	N	N	N	N
Antimicrobial resistance	N	N	N	N	N	N
Surgical intervention	Y	Y	Y	Y	Y	Y

Abbreviations: N, No; Y, Yes.

showed right submandibular gland area. The B-ultrasound in the submandibular area showed cystic structure of the right submandibular gland. The secretion was sent for bacterial culture and drug susceptibility test. The patient was given cefmetazole to fight infection. On the third day after admission, the submandibular pain and swelling were not significantly relieved, and the mass was not significantly reduced. The administration of cefmetazole was discontinued and changed to morpholinidazole and levofloxacin. On the seventh day after admission, the pain was less relieved than before, but there was no significant change in the mass. A 3.0 × 2.0 × 1.0 centimeter mass could be seen under the right jaw of the neck. The “ultrasound-guided abscess puncture and drainage” was given to drain about 4ml yellowish white pus. The results of pus culture showed that *E. corrodens* was cultured. Then morpholinidazole and levofloxacin injection were suspended, and ceftriaxone regimen was administered for the operation. The patient gave consent to medical treatment “the resection of deep abscess on the right side of the neck and drainage of right submandibular abscess under general anesthesia”, and ceftriaxone was continued to be administered after operation. The patient was recovered and discharged.

## 2.5 | Case 5

Patient 5, a 53-year-old male with a past history of after lumbar surgery. Without obvious inducement, the urination was slow, the range was shortened, the urinary rheology was fine, the low drainage after urine was not linear, and the feeling of urine was endless. The abovementioned symptoms had been repeated for more than 10 years without diagnosis and treatment. After 3 years of urethral stricture scar resection and urethral end-to-end anastomosis, the postoperative symptoms were significantly relieved. Later, the patient repeatedly had delayed micturition, shortened range, fine urinary rheology, low post micturition Lek, no line, and endless sense of urine, so he gave consent to urethral stricture dilation in the hospital many times, but the postoperative effect was poor. After admission, he gave consent to “the urethral stricture resection and urethral reconstruction”. Cefuroxime was administered to prevent infection. Generally, the postoperative condition was normal, without fever and obvious discomfort. On the fifth day

TABLE 3 Results of drug susceptibility test of six strains of *Eikenella corrodens*

Patient	1	2	3	4	5	6
Ciprofloxacin	S	S	S	S	S	S
Levofloxacin	S	S	S	S	S	S
Compound sulfamethoxazole	S	S	S	S	S	S
Penicillin	S	S	S	S	S	S
Ceftriaxone	S	S	S	S	S	S
Imipenem	S	S	S	S	S	S

Abbreviation: S, susceptible.

TABLE 2 Examination results of six patients with *Eikenella corrodens* infection

Patient	1	2	3	4	5	6
Routine blood test	Leukocyte count: 16.05 ( $\times 10^9/L$ ), neutrophils: 90.3 (%), lymphocytes: 3.6 (%)	Leukocyte count: 16.05 ( $\times 10^9/L$ ), neutrophils: 90.3 (%), lymphocytes: 3.6 (%)	Leukocyte count: 19.49 ( $\times 10^9/L$ ), neutrophils: 91.4 (%)	Leukocyte count: 20.46 ( $\times 10^9/L$ ), lymphocytes: 18.9 (%)	Leukocyte count: 9.61 ( $\times 10^9/L$ ), neutrophils: 80.4 (%), lymphocytes: 9.6%	Leukocyte count: 6.26 ( $\times 10^9/L$ ), neutrophils: 75.6 (%), lymphocytes: 13.1 (%)
h-CRP	209.59 (mg/L)	101.2 (mg/L)	101.2 (mg/L)	20.46 (mg/L)	34.48 (mg/L)	21.12 (mg/L)
Noninvasive exam	Imaging examination: revealed an abscess in the right neck	CT showed postoperative changes of the left lung and left pneumothorax	CT showed high density shadow with bubble in the lower lobe of the left lung, infectious lesion? A small amount of pleural effusion on the left	CT showed right submandibular gland area. B-ultrasound in the submandibular area: cystic structure of the right submandibular gland	No result	CT showed the postoperative changes of left brain abscess, and MRI showed necrotic lesions of the left temporal lobe. Combined with the medical history, it suggested that the possibility of brain abscess was high

TABLE 4 Courses of treatments of six patients with *Eikenella corrodens* infection

Patient	1	2	3	4	5	6
Antimicrobials used before MS identification	Piperacillin/tazobactam+vancomycin, vancomycin+cefoperazone/sulbactam	Cefoperazone/sulbactam	Moxifloxacin, biapenem	Azlocillin, morpholinonidazole levofloxacin	Cefuroxime, piperacillin/tazobactam	Meropenem+vancomycin
Surgical intervention	Cervical nerve entrapment release, abscess incision and drainage, chronic ulcer repair, negative pressure sealing drainage	Closure of bronchopleural fistula	Ultrasound-guided percutaneous drainage of left pleural effusion	Excision of deep abscess on the right side of the neck and drainage of right submandibular abscess	No surgical intervention	Excision of temporal lobe abscess and repair of the skull base
Antimicrobials used after MS identification	Clindamycin+moxifloxacin	Cefoperazone/sulbactam	Biapenem+levofloxacin	Ceftriaxone	Cefazoxime	Meropenem+vancomycin
Prognosis	Discharge	Transferred to another hospital	Discharge	Discharge	Discharge	Discharge

after operation, the maximum temperature was 38.5°C. The examination of the wound showed that there was a slight exudation around the wound, and the leukocyte count was high. Considering the infection of the surgical incision, piperacillin/tazobactam was administered for antimicrobial therapy. The result of pus culture of wound secretion was *E. corrodens*. According to the results of the drug susceptibility test, piperacillin/tazobactam was terminated, and the administration regimen was changed to cefazoxime. The patient was recovered and discharged.

## 2.6 | Case 6

Patient 6, a 64-year-old male with a past history of hypertension, type II diabetes, nasopharyngeal cancer (endoscopic sinus surgery 3 months ago), and drainage after brain abscess puncture. The patient had headache without obvious inducement for 2 months, mainly in the left temporal part, showing intermittent dull pain, which could be relieved by taking short rest. Since then, it occurred repeatedly and gradually worsened. Magnetic resonance imaging (MRI) performed implied that “space occupying in the left temporal lobe and brain abscess should be considered”. He underwent “puncture and drainage of brain abscess under neuronavigation”. After discharge, the patient's general condition was normal, but he occasionally had a headache, not severe, and he could tolerate it. Then, he was admitted with “brain abscess”. The leukocyte count was high and h-CRP increased. CT indicated the post-operative changes of left brain abscess, and MRI indicated the necrotic lesions of the left temporal lobe. After excluding the contraindications of operation, “craniotomy, temporal lobe abscess resection, and skull base repair” were performed, and cefuroxime was intravenously injected before operation to prevent infection. The patient was treated with meropenem and vancomycin after operation. The pus culture showed *E. corrodens*. Meropenem and vancomycin were administered to fight infection. The patient was recovered and discharged.

## 2.7 | Strains identification and drug susceptibility tests

All six strains had typical corroding colony morphology, and all were identified as *E. corrodens* according to the MALDI-TOF MS (VITEK MS, bioMerieux) system. Drug susceptibility tests were performed according to Clinical and Laboratory Standards Institute (CLSI) 2020.

## 2.8 | Clinical characteristics of patients with *E. corrodens* infections and microbiological features of the strains

The general clinical data, laboratory test results, and courses of treatment of the abovementioned six patients are summarized in Tables 1–4.

## 3 | RESULTS

It can be seen from Table 1 that the average age of six patients (five males and one female) in this article is 56.8 years old (53–64), including three cases of head and neck, two cases of chest, and one case of postoperative wound infection. The infections of the six patients were suppurative infection. The deep infection was treated with surgical drainage or abscess resection plus antimicrobials (Table 4).

It can be seen from Table 2 that the inflammatory indexes of the six patients in this article, including white blood cell count and h-CRP, increased in varying degrees. Auxiliary examination indicated abscess or effusion.

It can be seen from Table 3 that the six strains of *E. corrodens* in this article were susceptible to penicillin and had not produced penicillin  $\beta$ -lactamase. The disease spectrum and drug resistance were consistent with the retrospective analysis of 43 patients diagnosed as *E. corrodens* infection by Sheng et al.<sup>9</sup> during 6 years (1993–1998).

## 4 | DISCUSSION

*Eikenella corrodens* is an opportunistic infection bacterium with high nutritional requirements and rare clinical infection. Head and neck infection by *E. corrodens* is the most common type of infection. In this report, three cases were head and neck infection and patient-6 had a history of nasopharyngeal malignancy which is the sensitive factor of *E. corrodens* infection.

*Eikenella corrodens* is a relatively rare microorganism in lung infection. Infection can occur alone or mixed with other common respiratory pathogens. It can cause infection in people with various susceptible factors, such as aspiration, alcoholism, immunosuppression, cardiovascular disease, and diabetes.<sup>10</sup> The two cases mentioned above have predisposing factors. Patient-2 had a history of pulmonary malignancy, Patient-3 has diabetes, and these two patients had pleural effusion. Patient-2 also developed mixed infection with *P. mirabilis*.

*Eikenella corrodens* is a part of oral symbiosis and a normal flora on the mucosal surface of the gastrointestinal tract and urinary tract. Urinary tract infection caused by it has also been reported,<sup>11</sup> but it is not common. In this report, patient-5 was infected with *E. corrodens* after urethral surgery, and this type of infection has not been reported. Therefore, urinary tract surgery is also a susceptible factor of *E. corrodens* infection.

*Eikenella corrodens* has a somewhat peculiar antimicrobial susceptibility pattern, being susceptible to penicillin but resistant to penicillinase-resistant penicillins, such as dicloxacillin, and resistant to macrolides, metronidazole, and aminoglycosides.<sup>12</sup> Antimicrobial agents to treat infections of *E. corrodens* can be determined according to whether it is produced or not  $\beta$ -lactamase. According to our results of drug susceptibility test, none of the six strains produced  $\beta$ -lactamase, and all strains were susceptible to penicillin, ceftriaxone, imipenem, quinolones, and compound sulfamethoxazole (Table 3). The inflammation caused by *E. corrodens* is mostly suppurative

infection, which can be accompanied by abscess and various suppurative indexes (leukocyte and ESR) rise.<sup>9</sup> Therefore, timely and sufficient surgical drainage of abscess and clearance of abscess tissue should be considered for infection of *E. corrodens*.<sup>9</sup> It is also reported that relevant analysis and statistics have been made. Among the 54 patients, in addition to 14 patients with surgical contraindications, 36 of the other 40 patients need incision and drainage in addition to antimicrobial treatment.<sup>13</sup> All six patients except one case of post-operative wound infection were treated with the abovementioned methods.

With the use of antimicrobials and the change of living environment, there are more and more cases of conditional pathogen infection, and the disease spectrum of *E. corrodens* is becoming more and more complex. *Eikenella corrodens* with  $\beta$ -lactamase also has appeared.<sup>14</sup> However, there is a lack of systematic research on the clinical characteristics of this bacterium in recent years. So, it is of great significance to study the clinical characteristics of *E. corrodens* infection, timely diagnosis, and effective treatment.

### CONFLICT OF INTEREST

The authors declare no competing interests.

### AUTHOR CONTRIBUTION

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Li Li and Xing-bei Weng. The first draft of the manuscript was written by Li Li, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

### ETHICS APPROVAL

Ethics approval was obtained from the Ethics Committee of Ningbo First Hospital. This study was performed in line with the principles of the Declaration of Helsinki.

### DATA AVAILABILITY STATEMENT

Yes. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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