Case Report

Moraxella catarrhalis bacteraemia associated with prosthetic vascular graft infection

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Moraxella catarrhalis, formerly called *Branhamella catarrhalis*, '*Neisseria catarrhalis*' or '*Micrococcus catarrhalis*', is a Gram-negative, aerobic diplococcus frequently found as a colonizer of the upper respiratory tract. Over the last 20–30 years, this bacterium has emerged as a genuine pathogen, and is now considered an important cause of otitis media in children and an aetiological agent in pneumonia in adults with chronic obstructive pulmonary disease. However, bacteraemia due to *M. catarrhalis* has rarely been reported. Presented here is a case of *M. catarrhalis* bacteraemia associated with prosthetic vascular graft infection along with a review of the relevant literature.

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Introduction

Moraxella catarrhalis, formerly called *Branhamella catarrhalis*, '*Neisseria catarrhalis*' or '*Micrococcus catarrhalis*', is a Gram-negative, aerobic diplococcus frequently found as a colonizer of the upper respiratory tract. Over the last 20–30 years, this bacterium has emerged as a genuine pathogen and is now considered an important cause of otitis media in children (Enright & McKenzie, 1997). Furthermore, *M. catarrhalis* is an important cause of lower respiratory tract infections, particularly in adults with chronic obstructive pulmonary disease (COPD) (Verduin *et al.*, 2002). In immunocompromised hosts, the bacterium can cause a variety of severe infections, including pneumonia, endocarditis, septicaemia and meningitis (Verduin *et al.*, 2002). In addition, the emergence of *M. catarrhalis* as a pathogen in the last decade, together with the increasing prevalence of β -lactamase-producing strains, has renewed interest in this bacterial species. Bacteraemia due to *M. catarrhalis* has rarely been reported, and only 61 documented cases have been reported from 1966 to 1998 (Thórsson *et al.*, 1998). Over the last 20 years, a total of 34 325 samples have been examined by blood culture methods at Saga University

Hospital. Among them, a total of 4295 samples (12%) were culture positive, but no *M. catarrhalis* has been detected for a period of 20 years. We present here a case of a 53-year-old male with postoperative aortic dissection (type B) who developed clinical sepsis possibly due to *M. catarrhalis*. We have also reviewed reports of *M. catarrhalis* bacteraemia in the English-language medical literature.

Case report

Fourteen years ago, a 53-year-old male was diagnosed with aortic dissection (type B) and hypertension. He underwent an operation for the replacement of the dissected descending aorta with prosthetic vascular grafts. He had smoked 30 cigarettes per day for 35 years, but he did not have clinical signs of COPD or diabetes. In December 2008, he was admitted to hospital (Hiramatsu Hospital, Ogi City, Japan) for investigation of a 3 week history of watery diarrhoea (3–4 incidences per day, no pain, vomiting or nausea). Laboratory tests after admission revealed anaemia (7.6 g haemoglobin dl⁻¹), substantial inflammation (15 500 white blood cells mm⁻³, 7 mg C-reactive protein dl⁻¹), a decrease in platelets (20 000 platelets dl⁻¹) and compromised renal function (132.3 mg blood urea nitrogen dl⁻¹, 3.6 mg creatinine dl⁻¹). Based on the diagnosis of possible haemolytic uraemic syndrome caused by

Abbreviations: COPD, chronic obstructive pulmonary disease; CPFX, ciprofloxacin; CT, computed tomography; CTM, cefotiam; CTRX, ceftriaxone; TAZ/PIPC, tazobactam/piperacillin.

Fig. 1. Chest CT scan showing inflammatory soft tissue and air signs around the descending aortic graft. Air signs are indicated by arrows.

enterohaemorrhagic *Escherichia coli* O157, he was transferred to Saga University Hospital. Clinical findings were as follows: body temperature, 35.6 °C; blood pressure, 98/60 mmHg; heart rate, 60 beats min⁻¹; respiratory rate, 22–28 breaths min⁻¹ and oxygen saturation, 96 % (room air). Disseminated petechial rashes were present on his back and legs, and hepatosplenomegaly was observed. These findings

indicated the possibility of septic shock. Antibiotic therapy, with 2 g ceftriaxone (CTRX) given intravenously every 12 h, was initiated on the 2nd day of hospitalization, because blood cultures obtained on admission grew *M. catarrhalis*, which was β -lactamase-positive and susceptible to CTRX, azithromycin and levofloxacin. Because there had been no cases of *M. catarrhalis* bacteraemia in 34 325 blood samples over a period of 20 years at Saga University Hospital, the species was identified by sequencing the 16S rRNA gene (about 1500 bp) as well as by conventional biological tests using the Vitek 2 system (bioMérieux). A BLASTN search revealed that the sequence of the isolate shared a 99 % (1478/1488) homology with that of the *M. catarrhalis* type strain (ATCC 25238), confirming that the isolate was *M. catarrhalis*. Abdominal computed tomography (CT) scans showed no sign of biliary tract infection, and the urine culture yielded no bacterial growth. No enterohaemorrhagic *E. coli*, *Salmonella*, *Shigella*, *Vibrio* or *Campylobacter* were detected in a stool culture. A chest CT scan revealed air signs around the prosthetic vascular graft of the distal aortic arch proximal to the descending aorta, indicating the presence of graft infection (Fig. 1). Furthermore, a transoesophageal ultrasound detected a haematoma around the anastomosis of the prosthetic vascular graft, suggesting that the blood oozing from the graft was possibly due to bacterial infection. Endocarditis was less likely because the transoesophageal echocardiography showed no mass lesion in the cardiac cavity. From these observations, we diagnosed that the patient had developed sepsis from *M. catarrhalis* associated with an infection of the prosthetic vascular graft; however, no point

Fig. 2. Clinical course of the infection. A, Ampicillin; CD, *C. difficile*; CHDF, continuous haemodiafiltration; MRSA, methicillin-resistant *S. aureus*; VCM, vancomycin; +, positive; -, negative.

Table 1. Primary infection and outcome in patients older than 13 years with *M. catarrhalis* bacteraemia

This table is remade with a modified table format from a report by Thórsson *et al.* (1998).

Case no.	Age (years)/sex	Underlying condition	Predisposing condition	Primary infection	Outcome	Reference
1	53/M	Dissecting aneurysm of the aorta (type B)	Others	Bacteraemia	Recovered	Present report
2	69/F	Breast cancer	Immunodeficiency	Bacteraemia	Recovered	Christensen & Bruun (1985)
3	63/F	AML	Immunodeficiency	Bacteraemia	Recovered	Saito <i>et al.</i> (1988)
4	51/F	AML	Immunodeficiency	Bacteraemia	Recovered	Saito <i>et al.</i> (1988)
5	39/F	CML	Immunodeficiency	Bacteraemia	Recovered	Saito <i>et al.</i> (1988)
6	39/F	None	None	Bacteraemia	Recovered	Mortlock (2004)
7	34/M	Kugelberg Welander syndrome	Others	Bacteraemia	Recovered	Westendorp <i>et al.</i> (2005)
8	29/F	ALL	Immunodeficiency	Bacteraemia	Recovered	Ioannidis <i>et al.</i> (1995)
9	15/M	AML	Immunodeficiency	Bacteraemia	Recovered	Saito <i>et al.</i> (1988)
10	75/F	Agammaglobulinaemia	Immunodeficiency	Pneumonia	Fatal	Sugiyama <i>et al.</i> (2000)
11	71/M	Lung cancer	Immunodeficiency	Pneumonia	Fatal	Wallace & Oldfield (1990)
12	64/M	COPD, seizure, MV	Impaired airway defences	Pneumonia	Fatal	Srinivasan <i>et al.</i> (1981)
13	17/F	Viral pneumonia	Impaired airway defences	Pneumonia	Fatal	Thórsson <i>et al.</i> (1998)
14	87/M	COPD	Impaired airway defences	Pneumonia	Recovered	Collazos <i>et al.</i> (1992)
15	74/F	MI, DM	Others	Pneumonia	Recovered	Choo & Gantz (1989)
16	71/M	Bronchiectasis	Impaired airway defences	Pneumonia	Recovered	Ioannidis <i>et al.</i> (1995)
17	70/M	Lymphoma	Immunodeficiency	Pneumonia	Recovered	Collazos <i>et al.</i> (1992)
18	69/M	COPD	Impaired airway defences	Pneumonia	Recovered	Thórsson <i>et al.</i> (1998)
19	48/M	PLL/CLL	Immunodeficiency	Pneumonia	Recovered	Thórsson <i>et al.</i> (1998)
20	44/F	Breast cancer	Immunodeficiency	Pneumonia	Recovered	Bodasing & Kennedy (2002)
21	41/M	CML	Immunodeficiency	Pneumonia	Recovered	Thórsson <i>et al.</i> (1998)
22	30/M	Quadriplegia, MV	Impaired airway defences	Pneumonia	Recovered	Ioannidis <i>et al.</i> (1995)
23	19/M	DM	Others	Pneumonia	Recovered	Malkamäki <i>et al.</i> (1983)
24	83/F	COPD	Impaired airway defences	Bronchitis	Recovered	Bannatyne & Kolodej (1985)
25	76/M	COPD	Impaired airway defences	Bronchitis	Recovered	Domingo <i>et al.</i> (1995)
26	68/M	None	None	Sinusitis	Recovered	Alaesus & Stiernstedt (1991)
27	24/F	AML	Immunodeficiency	Sinusitis	Recovered	Henny <i>et al.</i> (1984)
28	40/M	Systemic lupus erythematosus	Others	Urinary tract infection	Recovered	Guthrie <i>et al.</i> (1988)
29	41/M	DM	Others	Arthritis	Recovered	Melendez & Johnson (1991)
30	37/M	None	Others	Endocarditis	Recovered	Stefanou <i>et al.</i> (2000)

ALL, Acute lymphoblastic leukaemia; AML, acute myeloid leukaemia; CML, chronic myeloid leukaemia; DM, diabetes mellitus; F, female; M, male; MI, myocardial infarction; MV, mechanical ventilation; PLL/CLL, prolymphocytic leukaemia/chronic lymphocytic leukaemia.

of entry for the infection could be defined. Conservative treatment (Fig. 2), including antibiotic therapy and haemodialysis, was administered because the patient was in an inoperable state with disseminated intravascular coagulation and acute renal failure. On the fifth day of hospitalization, we de-escalated the antibiotic therapy from CTRX to 1 g cefotiam (CTM) given intravenously every 8 h. On the eighth day of hospitalization, the patient was intubated and mechanically ventilated for hypervolume-induced respiratory failure, and continuous haemodiafiltration was initiated on the next day. On the tenth day of hospitalization, we changed antibiotics from CTM to 200 mg ciprofloxacin (CPFX) given intravenously every 12 h. On the 17th day of hospitalization, the CPFX was changed to 2 g ampicillin given intravenously every 12 h

because of liver dysfunction. Although these antibiotic therapies were continuously administered during the patient's hospitalization, the inflammation around the descending aorta next to the aortic graft expanded to the left lung, and resulted in haemoptysis. Therefore, 2.25 g tazobactam/piperacillin (TAZ/PIPC) was initiated intravenously every 12 h on the 18th day of hospitalization, but he developed pneumonia caused by meticillin-resistant *Staphylococcus aureus*. The addition of 500 mg vancomycin given intravenously every 24 h was immediately initiated, and the pneumonia improved. However, drug fever was suspected because the fever persisted, so the TAZ/PIPC was stopped. On the 27th day of hospitalization, a test for *Clostridium difficile* toxin was positive in his diarrhoea, indicating pseudomembranous colitis. Metronidazole

Table 2. Primary infection and outcome in patients younger than 12 years with *M. catarrhalis* bacteraemia

This table is remade with a modified table format from a report by Thórsson *et al.* (1998).

Case no.	Age/sex	Underlying condition	Predisposing condition	Primary infection	Outcome	Reference
31	4 years/M	ALL	Immunodeficiency	Bacteraemia	Recovered	Bannatyne & Kolodej (1985)
32	3 years/M	Burkitt's lymphoma	Immunodeficiency	Bacteraemia	Recovered	Henny <i>et al.</i> (1984)
33	3 years/F	Neutropenia	Immunodeficiency	Bacteraemia	Recovered	Bonadio (1988)
34	4 years/M	Ependymoma	Immunodeficiency	Bacteraemia	Fatal	Bannatyne & Kolodej (1985)
35	3 years/F	AIDS	Immunodeficiency	Bacteraemia	Fatal	Wong & Ross (1988)
36	1 month/F	Neutropenia	Immunodeficiency	Bacteraemia	Fatal	Bonadio (1988)
37	4 years/M	ALL	Immunodeficiency	Pneumonia	Recovered	Cimolai & Adderley (1989)
38	30 months/M	ALL	Immunodeficiency	Pneumonia	Recovered	Saito <i>et al.</i> (1988)
39	30 months/M	Smoke inhalation	Impaired airway defences	Pneumonia	Recovered	Dietrich <i>et al.</i> (1990)
40	2 years/M	ALL	Immunodeficiency	Pneumonia	Recovered	Saito <i>et al.</i> (1988)
41	22 months/M	Hydrocephalus, MV	Impaired airway defences	Pneumonia	Recovered	Ioannidis <i>et al.</i> (1995)
42	19 months/F	ALL	Immunodeficiency	Pneumonia	Recovered	Doern <i>et al.</i> (1981)
43	3 years/F	IgG deficiency	Immunodeficiency	Pneumonia	Fatal	Bryant (1983)
44	4 years/F	Cerebral palsy	Others	Sinusitis	Recovered	Baron & Shapiro (1985)
45	20 months/F	Chronic otitis	Others	Sinusitis	Recovered	Meyer <i>et al.</i> (1995)
46	16 months/M	None	None	Sinusitis	Recovered	Rotta & Asmar (1994)
47	19 months/M	Chickenpox	Others	Sinusitis, preseptal cellulitis	Recovered	Abuhammour <i>et al.</i> (1999)
48	16 months/M	None	None	Sinusitis, preseptal cellulitis, otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
49	20 months/M	HbSS	Others	Sinusitis, otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
50	19 months/M	None	None	Sinusitis, otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
51	27 months/M	None	None	Otitis media	Recovered	Massam & Green (1982)
52	2 years/F	ALL	Immunodeficiency	Otitis media	Recovered	Bonadio (1988)
53	2 years/M	Hydrocephalus	Others	Otitis media	Recovered	Ioannidis <i>et al.</i> (1995)
54	23 months/M	Asthma	Impaired airway defences	Otitis media	Recovered	Meyer <i>et al.</i> (1995)
55	23 months/M	Single ventricle (transposition of the vessels)	Others	Otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
56	17 months/F	Transposition of vessels	Others	Otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
57	1 year/M	Malignancy	Immunodeficiency	Otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
58	10 months/M	None	None	Otitis media	Recovered	Abuhammour <i>et al.</i> (1999)
59	32 months/M	None	None	Otitis media, pneumonia	Recovered	Abuhammour <i>et al.</i> (1999)
60	28 months/M	HbSC	Others	Otitis media, pneumonia	Recovered	Abuhammour <i>et al.</i> (1999)
61	19 months/F	AIDS	Immunodeficiency	Otitis media, pneumonia	Recovered	Abuhammour <i>et al.</i> (1999)
62	11 months/F	Sickle cell trait	Others	Otitis media, pneumonia	Recovered	Thórsson <i>et al.</i> (1998)
63	7 years/F	None	None	Pharyngitis	Recovered	Abuhammour <i>et al.</i> (1999)
64	11 months/M	None	None	Pharyngitis	Recovered	Baron & Shapiro (1985)
65	12 years/M	ALL	Immunodeficiency	Pharyngitis	Fatal	Burnett <i>et al.</i> (1975)
66	4 years/M	Cornelia de Lange syndrome	Others	Haemorrhagic pancreatitis	Fatal	Ohkusu <i>et al.</i> (2001)

ALL, Acute lymphoblastic leukaemia; F, female; HbSC, haemoglobin SC disease; HbSS, haemoglobin SS disease; M, Male; MV, mechanical ventilation.

(1000 mg per day orally) was initiated and continued for 14 days. His diarrhoea stopped, and the fever gradually subsided. The inflammatory soft tissue and air signs around the descending aortic graft had almost disappeared in the follow-up chest CT. He recovered fully after completing the 7 week course of treatment. This is believed to be the first reported case of *M. catarrhalis* bacteraemia associated with prosthetic vascular graft infection.

Discussion

A total of four blood cultures (four sets) for the patient were positive for *M. catarrhalis*. Although blood cultures taken 2 days later were negative, the follow-up chest CT scan 7 days later showed inflammatory soft tissue and air space signs around the descending aortic graft. The radiographic finding of air bubbles around a surgically placed prosthetic graft is assumed to be a sign of infection until proven otherwise (Orton *et al.*, 2000; Calligaro *et al.*, 2003; Silberfein *et al.*, 2006). Strictly speaking, it remains unclear whether or not the aortic graft infection was caused by *M. catarrhalis* in this patient, because the haematoma around the aortic graft was not aspirated and hence not cultured. However, *M. catarrhalis* bacteraemia was clinically considered to be associated with the prosthetic vascular graft infection.

The molecular identification of a bacterial species was very useful in this case because bacteraemia due to *M. catarrhalis* has rarely been reported. We used PubMed (<http://www.ncbi.nlm.nih.gov/PubMed/>) to search for literature on *M. catarrhalis* bacteraemia with the following index words: *Moraxella* (*Branhamella*) *catarrhalis* bacteraemia. A total of 63 published studies were found in the search. Details of 66 reported *M. catarrhalis* bacteraemia cases with patients within an age range of 1 week to 87 years, from the 63 papers and the case presented here, are shown in Tables 1 and 2. Some patients are not listed in the Table because age, gender, underlying disease, primary infection and outcomes for individual patients were not reported in these cases. We classified the patients by age into two groups: one group included patients older than 13 years (Table 1) and the other group included patients younger than 12 years (Table 2).

As shown in Table 1, 30 patients were older than 13 years; the mean age was 51 years and the gender ratio (male/female) was 1.5/1. Thirteen patients (43 %) were immunodeficient, and eight patients (27 %) had impaired airway defences, such as the impairment due to COPD or the requirement for mechanical ventilation. In nine cases (30 %), bacteraemia occurred in either healthy individuals (cases 6, 26 and 30) or individuals with no predisposing conditions for bacteraemia (cases 1, 7, 15, 23, 27 and 28). As shown in Table 2, 36 patients were younger than 12 years; the mean age was 2.5 years and the gender ratio (male/female) was 2/1. Fifteen patients (42 %) were immunodeficient, and three patients (8 %) had impaired airway defences, such as bronchial asthma (case 54). In

contrast to the patients older than 13 years, 18 bacteraemia cases (50 %) occurred in either healthy individuals or individuals without predisposing conditions. Ahmed *et al.* (2008) reported that 14 of 17 *M. catarrhalis* bacteraemia patients younger than 13 years were immunocompetent. Among the 30 patients older than 13 years, 18 (60 %, cases 10–27) had bacteraemia as a result of respiratory tract illness, whereas a point of entry for the infection could not be defined in 9 patients (30 %, cases 1–9). Among the 36 patients younger than 12 years, 29 (81 %, cases 37–65) had respiratory tract illness. Point of entry for the infection could not be defined in only six patients (17 %, cases 31–36). *M. catarrhalis* bacteraemia, especially in children, would most probably result from a respiratory tract infection or colonization. This is consistent with the role of *M. catarrhalis* in acute otitis media, as well as its frequent carriage in the respiratory tract of young healthy children.

Ten of sixty-six patients (15 %, cases 10–13, 34–36, 43, 65 and 66) died following the *M. catarrhalis* bacteraemia. Seven of the ten patients (70 %) were immunodeficient. It was reported that all 17 patients with *M. catarrhalis* bacteraemia who were younger than 13 years survived (Ahmed *et al.*, 2008). Therefore, mortality may vary depending on comorbid illness and clinical presentation of the infection. Skin lesions such as purpuric and petechial rash were observed in the present case. Although there are no pathognomonic clinical signs suggesting *M. catarrhalis* bacteraemia, it has been reported that petechiae and purpura are seen in 25 % of patients, most commonly in children (Thórsson *et al.*, 1998).

Conclusion

Over the last decade, there has been an increase in the number of reported cases of invasive infection due to *M. catarrhalis*. *M. catarrhalis* should be considered in the differential diagnosis of septic shock and prosthetic vascular graft infections.

References

- Abuhammour, W. M., Abdel-Haq, N. M., Asmar, B. I. & Dajani, A. S. (1999). *Moraxella catarrhalis* bacteremia: a 10-year experience. *South Med J* **92**, 1071–1074.
- Ahmed, A., Broides, A., Givon-Lavi, N., Peled, N., Dagan, R. & Greenberg, D. (2008). Clinical and laboratory aspects of *Moraxella catarrhalis* bacteremia in children. *Pediatr Infect Dis J* **27**, 459–461.
- Alaeus, A. & Stiernstedt, G. (1991). *Branhamella catarrhalis* septicemia in an immunocompetent adult. *Scand J Infect Dis* **23**, 115–116.
- Bannatyne, R. M. & Kolodej, V. (1985). *Branhamella catarrhalis* bacteraemia and immunosuppression – part of a larger problem? *Diagn Microbiol Infect Dis* **3**, 65–67.
- Baron, J. & Shapero, E. D. (1985). Unsuspected bacteremia caused by *Branhamella catarrhalis*. *Pediatr Infect Dis J* **4**, 100–101.
- Bodasing, N. & Kennedy, D. (2002). *Moraxella catarrhalis* bacteraemia associated with *Mycoplasma pneumoniae* infection and pneumonia. *Scand J Infect Dis* **34**, 851–852.

- Bonadio, W. A. (1988). *Branhamella catarrhalis* bacteremia in children. *Pediatr Infect Dis J* 7, 738–739.
- Bryant, J. (1983). Fatal sepsis due to *Branhamella catarrhalis* and *Hemophilus influenzae* in a child with selective IgG deficiency. *Arch Pathol Lab Med* 107, 442.
- Burnett, A. K., Easton, D. J., Gordon, A. M. & Rowan, R. M. (1975). *Neisseria catarrhalis* septicaemia in acute lymphoblastic leukaemia. *Scott Med J* 20, 37–38.
- Calligaro, K. D., Veith, F. J., Yuan, J. G., Gargiulo, N. J. & Dougheerty, M. J. (2003). Intra-abdominal aortic graft infection: complete or partial graft preservation in patients at very high risk. *J Vasc Surg* 38, 1199–1205.
- Choo, P. W. & Gantz, N. M. (1989). *Branhamella catarrhalis* pneumonia with bacteremia. *South Med J* 82, 1317–1318.
- Christensen, J. J. & Bruun, B. (1985). Bacteremia caused by a β -lactamase producing strain of *Branhamella catarrhalis*. *Acta Pathol Microbiol Immunol Scand B* 93, 273–275.
- Cimolai, N. & Adderley, R. J. (1989). *Branhamella catarrhalis* bacteremia in children. *Acta Paediatr Scand* 78, 465–468.
- Collazos, J., de Miguel, J. & Ayarza, R. (1992). *Moraxella catarrhalis* pneumonia in adults: two cases and review of the literature. *Eur J Clin Microbiol Infect Dis* 11, 237–240.
- Dietrich, M. C., Gerding, R. L. & Kumar, M. L. (1990). *Branhamella catarrhalis* pneumonia with bacteremia in a pediatric patient with smoke inhalation. *J Burn Care Rehabil* 11, 71–73.
- Doern, G. V., Miller, M. J. & Winn, R. E. (1981). *Branhamella* (*Neisseria*) *catarrhalis* systemic disease in humans. Case reports and review of literature. *Arch Intern Med* 141, 1690–1692.
- Domingo, P., Puig, M., Pericas, R., Mirelis, B. & Prats, G. (1995). *Moraxella catarrhalis* bacteraemia in an immunocompetent adult. *Scand J Infect Dis* 27, 95.
- Enright, M. C. & McKenzie, H. (1997). *Moraxella* (*Branhamella*) *catarrhalis*-clinical and molecular aspects of a rediscovered pathogen. *J Med Microbiol* 46, 360–371.
- Guthrie, R., Bakenhaster, K., Nelson, R. & Woskobnick, R. (1988). *Branhamella catarrhalis* sepsis: a case report and review of the literature. *J Infect Dis* 158, 907–908.
- Henny, F. C., Mulder, C. J. J., Lampe, A. S. & van der Meer, J. W. N. (1984). *Branhamella catarrhalis* septicaemia in a granulocytopenic patient. *Infection* 12, 208–209.
- Ioannidis, J. P. A., Worthington, M., Griffiths, J. K. & Snyderman, D. R. (1995). Spectrum and significance of bacteremia due to *Moraxella catarrhalis*. *Clin Infect Dis* 21, 390–397.
- Malkamäki, M., Honkanen, E., Leinonen, M. & Mäkelä, P. H. (1983). *Branhamella catarrhalis* as a cause of bacteremic pneumonia. Case report. *Scand J Infect Dis* 15, 125–126.
- Massam, M. & Green, H. T. (1982). *Branhamella catarrhalis* septicaemia presenting as a convulsion. *Br J Clin Pract* 36, 116–117.
- Melendez, P. R. & Johnson, R. H. (1991). Bacteremia and septic arthritis caused by *Moraxella catarrhalis*. *Rev Infect Dis* 13, 428–429.
- Meyer, G. A., Shope, T. R., Waecker, N. J. Jr & Lanningham, F. H. (1995). *Moraxella* (*Branhamella*) *catarrhalis* bacteremia in children. A report on two patients and review of the literature. *Clin Pediatr (Phila)* 34, 146–150.
- Mortlock, S. (2004). *Moraxella catarrhalis* bacteraemia in an immunocompetent patient in Lahore, Pakistan. *Br J Biomed Sci* 61, 33–35.
- Ohkusu, K., Nakamura, A., Horie, H. & Udagawa, A. (2001). Fatal sepsis associated with acute pancreatitis caused by *Moraxella catarrhalis* in a child. *Pediatr Infect Dis J* 20, 914–915.
- Orton, D. F., LeVeen, R. F., Saigh, J. A., Culp, W. C., Fidler, J. L., Lynch, T. J., Goertzen, T. C. & McCowan, T. C. (2000). Aortic prosthetic graft infections: radiologic manifestations and implications for management. *Radiographics* 20, 977–993.
- Rotta, A. T. & Asmar, B. I. (1994). *Moraxella catarrhalis* bacteremia and preseptal cellulitis. *South Med J* 87, 541–542.
- Saito, H., Anaissei, E. J., Khardori, N. & Bodey, P. (1988). *Branhamella catarrhalis* septicemia in patients with leukemia. *Cancer* 61, 2315–2317.
- Silberfein, E. J., Lin, P. H., Bush, R. L., Zhou, W. & Lumsden, A. B. (2006). Aortic endograft infection due to *Pasteurella multocida* following a rabbit bite. *J Vasc Surg* 43, 393–395.
- Srinivasan, G., Raff, M. J., Templeton, W. C., Givens, S. J., Graves, R. C. & Melo, J. C. (1981). *Branhamella catarrhalis* pneumonia. Report of two cases and review of literature. *Am Rev Respir Dis* 123, 553–555.
- Stefanou, J., Agelopoulos, A. V., Sipsas, N. V., Smilakou, N. & Avlami, A. (2000). *Moraxella catarrhalis* endocarditis: case report and review of the literature. *Scand J Infect Dis* 32, 217–218.
- Sugiyama, H., Ogata, E., Shimamoto, Y., Koshibu, Y., Matsumoto, K., Murai, K., Miyashita, T., Ono, Y., Nishiya, H. & other authors (2000). Bacteremic *Moraxella catarrhalis* pneumonia in a patient with immunoglobulin deficiency. *J Infect Chemother* 6, 61–62.
- Thórsson, B., Haraldsdóttir, V. & Kristjánsson, M. (1998). *Moraxella catarrhalis* bacteraemia: a report on 3 cases and a review of the literature. *Scand J Infect Dis* 30, 105–109.
- Verduin, C. M., Hol, C., Fleer, A., van Dijk, H. & van Belkum, A. (2002). *Moraxella catarrhalis*: from emerging to established pathogen. *Clin Microbiol Rev* 15, 125–144.
- Wallace, M. R. & Oldfield, E. C., III (1990). *Moraxella* (*Branhamella*) *catarrhalis* bacteremia. A case report and literature review. *Arch Intern Med* 150, 1332–1334.
- Westendorp, I. C., Tiemessen, M. A., de Jong, M., Soomers, A., Wakelkamp, I. M. & Boersma, W. G. (2005). *Moraxella catarrhalis* sepsis in a patient with juvenile spinal muscle atrophy. *Neth J Med* 63, 227–229.
- Wong, V. K. & Ross, L. A. (1988). *Branhamella catarrhalis* septicemia in an infant with AIDS. *Scand J Infect Dis* 20, 559–560.