Case Report

Correspondence

Valarie W. Lyngdoh
drwvalarielyngdoh@gmail.com

Received 15 December 2014

Accepted 13 August 2015

Septicaemia caused by *Myroides* spp.: a case report

D. Elantamilan, Valarie W. Lyngdoh, Basabdatta Choudhury,
Annie B. Khyriem and Jyotisma Rajbongshi

Department of Microbiology, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya-793018, India

Introduction: *Myroides* spp. are aerobic, yellow-pigmented, non-fermentative Gram-negative rods considered to be low-grade opportunistic pathogens. However, their intrinsic resistance to commonly used antibiotics necessitates prompt identification and evaluation.

Case presentation: Here, we report a case of septicaemia caused by *Myroides* sp. A 36-year-old pregnant female was admitted to the intensive care unit at week 18 of gestation with a diagnosis of hydatidiform mole with acute renal failure and anaemia. Blood culture under aerobic conditions showed growth of round, smooth, convex, yellow-pigmented colonies on blood agar but which failed to grow on MacConkey agar, and the organism was identified as *Myroides* sp. Susceptibility testing showed that it was susceptible only to piperacillin + tazobactam and, following treatment, the patient recovered.

Conclusion: *Myroides* spp. has, until now, been regarded as an opportunistic pathogen and a rare cause of serious disease in immunocompromised subjects. However, it may cause serious disease, even in immunocompetent hosts, and its intrinsic resistance warrants appropriate testing and timely intervention.

Keywords: *Flavobacterium odoratum*; *Myroides* spp.; non-fermenter; septicaemia.

Introduction

Myroides spp. are aerobic, yellow-pigmented, Gram-negative, non-fermentative rods that are considered low-grade opportunistic pathogens. They have been identified as causative agents in urinary tract infections, pneumonia, meningitis, fasciitis and ventriculitis in immunocompromised patients and a few life-threatening infections have been reported in immunocompetent individuals. Here we discuss a case of septicaemia caused by *Myroides* sp.

Case report

A 36-year-old female was admitted to the intensive care unit at week 18 of gestation with a diagnosis of hydatidiform mole with acute renal failure and anaemia. The patient was given pre-surgical antibiotic prophylaxis with ceftriaxone and metronidazole. Suction and evacuation was done and the same antibiotics were continued. Postoperatively, considering her general condition, she was transferred back to the intensive care unit. Initial blood culture and urine culture following a surgical procedure were sterile. Her renal functions returned to normal and her haemoglobin status improved after transfusion. However, she developed fever with signs of septicaemia and her general condition subsequently deteriorated. She was started on empirical treat-

ment with ertapenem and tinidazole and a blood sample was sent for culture.

Blood culture under aerobic conditions showed growth of round, smooth, convex, yellow-pigmented colonies of 1–2 mm on blood agar (Fig. 1), but which failed to grow on MacConkey agar. The organism was a catalase- and oxidase-positive non-fermentative Gram-negative bacillus. Further evaluation of the isolate using conventional biochemical tests (VITEK 2 system, bioMérieux; and mini API identification system, Versikon B, bioMérieux) identified it as *Myroides* sp. Phenotypic differentiation between *Myroides odoratus* and *Myroides odoratimimus* is difficult, except for the fact that many strains of *M. odoratus* do not grow readily on MacConkey agar (Schreckenberger *et al.*, 2003; Deepa *et al.*, 2014). The source of the infection could not be traced.

Antimicrobial susceptibility testing was done on Mueller–Hinton agar by the Kirby–Bauer disc diffusion method and interpreted following Clinical Laboratory Standards Institute standards (CLSI, 2013), using the zone diameters for *Pseudomonas aeruginosa* (as there are no established standards for *Myroides* spp.). The isolate was sensitive only to piperacillin/tazobactam and was resistant to ampicillin, levofloxacin, ceftriaxone, ofloxacin, ceftazidime, imipenem and cefoperazone/sulbactam. The zone sizes obtained

Fig. 1. Yellow-pigmented colonies of *Myroides* spp. on nutrient agar.

in the disc diffusion method and the MIC of the antimicrobial agents obtained using the VITEK 2 system (v.5.04) are shown in Tables 1 and 2, respectively. Metallo- β -lactamase production was detected by the double disc synergy method using imipenem and imipenem + EDTA. Treatment with ertapenem was stopped and piperacillin + tazobactam was started. The patient responded clinically to the revised therapy and subsequent blood cultures were sterile.

Discussion

Members of the genus *Myroides* were first isolated in 1923 and classified as *Bacterium faecale aromaticum* (Stutzer, 1923). Later, they were named as *Flavobacterium odoratum* (Stutzer & Kwaschnina, 1929). However, *F. odoratum* was not included in the list of species of flavobacteria in Bergey's Manual of Systematic Bacteriology until 1984. In 1984, Holmes *et al.* redefined the genus and limited it to pigmented, strictly aerobic, non-motile bacteria with a G + C content ranging from 30 to 42 mol% (Hugo *et al.*, 2006). The organ-

Table 2. MICs of antimicrobial agents obtained using the VITEK 2 system

Antimicrobial agent	MIC ($\mu\text{g ml}^{-1}$)
Ampicillin/sulbactam	≥ 32
Ticarcillin	≤ 16
Piperacillin	≤ 16
Piperacillin/tazobactam	≤ 16
Ceftazidime	≥ 64
Ceftriaxone	≥ 64
Cefoperazone/sulbactam	≥ 64
Cefepime	≥ 64
Imipenem	≥ 16
Meropenem	≥ 16
Amikacin	≥ 64
Gentamicin	≥ 16
Tobramycin	≥ 16
Ciprofloxacin	≥ 4
Levofloxacin	≥ 8
Tetracycline	≥ 16
Tigecycline	≥ 8
Colistin	≥ 16
Trimethoprim/sulfamethoxazole	≥ 320

isms historically classified as part of the genus *Flavobacterium*, family *Bacteriaceae*, tribe *Chromobacteriaceae* included aerobic, yellow-pigmented, non-motile, non-fermenting, Gram-negative rods, which produce a characteristic fruity odour and appear as lightly yellow-pigmented because of the presence of flexirubin pigment (Bernardet *et al.*, 1996). Among the members of this genus, *F. odoratum* was recognized to retain distinctive features (such as lack of gliding motility, good growth at 37 °C, halotolerance and several differences in fatty acid profile), which clearly warranted its reclassification. Therefore, in 1996, a new genus, *Myroides*, was created, in which two species deriving from a single phylogenetic branch (namely, *M. odoratus*, formerly *F. odoratum*, and a second species, *M. odoratimimus*) were included (Vancanneyt *et al.*, 1996).

Genus *Myroides* (Myroi'des. Gr. n. myron, perfume; Gr. adj. -oides, similar to; N. L. masc. n. *Myroides*, resembling perfume) are Gram-negative rods that are 0.5 μm in diameter and 1–2 μm long, but longer rods and long chains (containing four to ten cells) may occur in broth medium. They are strictly aerobic with good growth on nutrient agar and MacConkey agar (Bernardet *et al.*, 1996). Among the species in this genus, *M. odoratus* was found to show poor growth on MacConkey agar. Testing of 74 strains by the Centers for Disease Control and Prevention showed that the type strain of *M. odoratus* did not grow on MacConkey agar, whereas that of *M. odoratimimus* grew readily (Schreckenberger *et al.*, 2003) and a similar case of *M. odoratus* showing no growth on MacConkey agar was also reported recently by Deepa *et al.* (2014). *Myroides* spp. form non-haemolytic colonies on blood agar. The biochemical and growth

Table 1. Inhibition zone size around antimicrobial agents tested by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar

Antimicrobial agent	Zone of inhibition (mm)
Ampicillin	No zone
Levofloxacin	No zone
Ofloxacin	No zone
Ceftazidime	No zone
Ceftriaxone	No zone
Imipenem	No zone
Meropenem	No zone
Cefoperazone + sulbactam	No zone
Piperacillin	20 mm
Piperacillin + tazobactam	22 mm

Table 3. Growth and biochemical characteristics of *Myroides* spp.

Characteristics	Result
Temperature	
Growth occurs best at:	18–37 °C
No growth at:	≤5 °C and ≥42 °C
Colony characteristics	
Pigment	Yellow
Odour	Fruity
Motility	No
Catalase test	Positive
Oxidase test	Positive
Urease	Produced
Gelatin	liquefied
Indole	Not formed
Nitrite (but not nitrate)	Reduced
Sugars	Non-saccharolytic
Aesculin	Not hydrolysed
Arginine dihydrolase	Absent
β-Galactosidase	Absent

characteristics of this organism are summarized in Table 3 (Bernardet *et al.*, 1996).

The genus *Myroides* comprises two species, *Myroides odoratus* and *Myroides odoratimimus* at the time of reclassification (Schreckenberger *et al.*, 2003). In recent years, three novel species (*Myroides pelagicus*, *Myroides profundus* and *Myroides marinus*) were isolated from seawater (Yoon *et al.*, 2006; Zhang *et al.*, 2008; Cho *et al.*, 2011). Although commonly found in soil and water, *Myroides* spp. are rare clinical isolates and are often not considered pathogenic. The organism has been isolated from urine, blood, wounds and respiratory secretions (Holmes *et al.*, 1979; Yağci *et al.*, 2000). *Myroides* spp. have been found to be associated with various clinical infections ranging from recurrent cellulitis, post-operative wound infections and necrotizing fasciitis to severe septicaemia. Cases of endocarditis and ventriculitis have also been reported (Maraki *et al.*, 2012; Benedetti *et al.*, 2011). Most of the cases were seen in immunocompromised patients suffering from decompensated liver disease, end-stage renal disease, prematurity and advanced neoplasms (Maraki *et al.*, 2012; Benedetti *et al.*, 2011). A nosocomial outbreak of seven cases of urinary tract infection by *M. odoratimimus* was reported by Ktari *et al.* (2012).

Various recent studies have pointed out intrinsic features of *Myroides* spp. that could help to understand their ability to colonize ubiquitous environments. It has been suggested that their wide distribution in the environment, as well as their ability to autoaggregate and coaggregate to form biofilms, might explain the ability to infect debilitated or immunosuppressed hosts. The cause of such infections is a result of either contact with environmental strains or through nosocomial transmission (Benedetti *et al.*, 2011).

In nosocomial transmission, the source of these infections is often unknown, although water in the hospital environment is frequently suspected of carrying the organisms (Hugo *et al.*, 2006).

The treatment of *Myroides* sp. infection is often difficult, as most strains are resistant to the β-lactams, including aztreonam and carbapenems, and exhibit variable susceptibility to aminoglycosides, quinolones and sulfamethoxazole (Chang *et al.*, 1997; Fass *et al.*, 1996; Fraser and Jorgensen, 1997; Crum-Cianflone *et al.*, 2014; Deepa *et al.*, 2014; Green *et al.*, 2001; Ktari *et al.*, 2012; Maraki *et al.*, 2012). The resistance to commonly used antibiotics and the variable susceptibility seen in these studies necessitate appropriate antimicrobial susceptibility testing, and an awareness among clinicians is essential for prompt switching of treatment from empirical antibiotics. *Myroides* spp. have been found to harbour a KPC-2 carbapenemase, which can hydrolyse expanded-spectrum cephalosporins and carbapenems (Kuai *et al.*, 2011). The production of chromosome-encoded metallo-β-lactamases has also been documented in both *M. odoratus* (TUS-1) and *M. odoratimimus* (MUS-1) (Mammeri *et al.*, 2002).

The strain isolated from our patient retained susceptibility only to piperacillin + tazobactam and was resistant to all penicillins and cephalosporins, as well as to aminoglycosides, quinolones and carbapenems.

Conclusion

Myroides spp. has, until now, been regarded as an opportunistic pathogen and only as a rare cause of serious disease in immunocompromised subjects. However, many recent reports suggest that it may cause serious disease, even in immunocompetent hosts, and its intrinsic resistance warrants appropriate testing and timely intervention.

References

- Benedetti, P., Rasse, M., Pavan, G., Sefton, A. & Pellizzer, G. (2011). Septic shock, pneumonia, and soft tissue infection due to *Myroides odoratimimus*: report of a case and review of *Myroides* infections. *Infection* **39**, 161–165.
- Bernardet, J.-F., Segers, P., Vancanneyt, M., Berthe, F., Kersters, K. & Vandamme, P. (1996). Cutting a Gordian knot: emended classification and description of the genus *Flavobacterium*, emended description of the family *Flavobacteriaceae*, and proposal of *Flavobacterium hydatis* nom. nov. (basonym, *Cytophaga aquatilis* Strohl and Tait 1978). *Int J Syst Bacteriol* **46**, 128–148.
- Chang, J. C., Hsueh, P. R., Wu, J. J., Ho, S. W., Hsieh, W. C. & Luh, K. T. (1997). Antimicrobial susceptibility of flavobacteria as determined by agar dilution and disk diffusion methods. *Antimicrob Agents Chemother* **41**, 1301–1306.
- Cho, S.-H., Chae, S.-H., Im, W.-T. & Kim, S. B. (2011). *Myroides marinus* sp. nov., a member of the family *Flavobacteriaceae*, isolated from seawater. *Int J Syst Evol Microbiol* **61**, 938–941.
- CLSI (2013). *Performance Standards for Antimicrobial Susceptibility Testing*, 23rd Informational Supplement M100-S23. Wayne, PA: Clinical and Laboratory Standards Institute.

- Crum-Cianflone, N. F., Matson, R. W. & Ballon-Landa, G. (2014). Fatal case of necrotizing fasciitis due to *Myroides odoratus*. *Infection* **42**, 931–935.
- Deepa, R., Venkatesh, K. G., Parveen, J. D., Banu, S. T. & Jayalakshmi, G. (2014). *Myroides odoratus* and *Chryseobacterium indologenes*: two rare isolates in the immunocompromised. *Indian J Med Microbiol* **32**, 327–330.
- Fass, R. J., Barnishan, J., Solomon, M. C. & Ayers, L. W. (1996). In vitro activities of quinolones, beta-lactams, tobramycin, and trimethoprim-sulfamethoxazole against nonfermentative Gram-negative bacilli. *Antimicrob Agents Chemother* **40**, 1412–1418.
- Fraser, S. L. & Jorgensen, J. H. (1997). Reappraisal of the antimicrobial susceptibilities of *Chryseobacterium* and *Flavobacterium* species and methods for reliable susceptibility testing. *Antimicrob Agents Chemother* **41**, 2738–2741.
- Green, B. T., Green, K. & Nolan, P. E. (2001). *Myroides odoratus* cellulitis and bacteremia: case report and review. *Scand J Infect Dis* **33**, 932–934.
- Holmes, B., Snell, J. J. & Lapage, S. P. (1979). *Flavobacterium odoratum*: a species resistant to a wide range of antimicrobial agents. *J Clin Pathol* **32**, 73–77.
- Holmes, B., Owen, R. J. & McMeekin, T. A. (1984). Genus *Flavobacterium* Bergey, Harrison, Breed, Hammer and Huntoon, 1923, 97AL In: N. R. Krieg and J. G. Holt (Eds.) *Bergey's Manual of Systematic Bacteriology* Williams and Wilkins Baltimore, MD **1**, 353–361.
- Hugo, C. J., Bruun, B. & Jooste, P. J. (2006). The genera *Empedobacter* and *Myroides*. In *The Prokaryotes*, pp. 532–538. Edited by M. Dworkin, S. Fallow, E. Rosenberg, K.-H. Schleifer & E. Stackebrandt. New York: Springer.
- Ktari, S., Mnif, B., Koubaa, M., Mahjoubi, F., Ben Jemaa, M., Mhiri, M. N. & Hammami, A. (2012). Nosocomial outbreak of *Myroides odoratimimus* urinary tract infection in a Tunisian hospital. *J Hosp Infect* **80**, 77–81.
- Kuai, S., Huang, L., Pei, H., Chen, Y. & Liu, J. (2011). Imipenem resistance due to class A carbapenemase KPC-2 in a *Flavobacterium odoratum* isolate. *J Med Microbiol* **60**, 1408–1409.
- Mammeri, H., Bellais, S. & Nordmann, P. (2002). Chromosome-encoded β -lactamases TUS-1 and MUS-1 from *Myroides odoratus* and *Myroides odoratimimus* (formerly *Flavobacterium odoratum*), new members of the lineage of molecular subclass B1 metalloenzymes. *Antimicrob Agents Chemother* **46**, 3561–3567.
- Maraki, S., Sarchianaki, E. & Barbagadakis, S. (2012). *Myroides odoratimimus* soft tissue infection in an immunocompetent child following a pig bite: case report and literature review. *Braz J Infect Dis* **16**, 390–392.
- Schreckenberger, P., Daneshvar, I. R., Weyant, R. S. & Hollis, D. G. (2003). *Acinetobacter*, *Achromobacter*, *Chryseobacterium*, *Moraxella*, and other non-fermentative Gram-negative rods. In *Manual of Clinical Microbiology*, 8th edn., pp. 749–779. Edited by P. R. Murray. Washington DC: American Society for Microbiology.
- Stutzer, M. J. (1923). Zur Frage Über die Fäulnisbakterien im Darm. *Zentralbl Bakteriol Parasitenkd Infektionskr Hyg Abt 1 Orig* **91**, 87–90.
- Stutzer, M. & Kwaschnina, A. (1929). Aussaaten aus den Fäzes des Menschen gelbe Kolonien bildende Bakterien (Gattung *Flavobacterium* u.a.). *Zentralbl Bakteriol Parasitenkd Infektionskr Hyg Abt 1 Orig* **113**, 219–225.
- Vancanneyt, M., Segers, P., Torck, U., Hoste, B., Bernardet, J.-F., Vandamme, P. & Kersters, K. (1996). Reclassification of *Flavobacterium odoratum* (Stutzer 1929) Strains to a new genus, *Myroides*, as *Myroides odoratus* comb. nov. and *Myroides odoratimimus* sp. nov. *Int J Syst Bacteriol* **46**, 926–932.
- Yağci, A., Cerikcioğlu, N., Kaufmann, M. E., Malnick, H., Söyletir, G., Babacan, F. & Pitt, T. L. (2000). Molecular typing of *Myroides odoratimimus* (*Flavobacterium odoratum*) urinary tract infections in a Turkish hospital. *Eur J Clin Microbiol Infect Dis* **19**, 731–732.
- Yoon, J., Maneerat, S., Kawai, F. & Yokota, A. (2006). *Myroides pelagicus* sp. nov., isolated from seawater in Thailand. *Int J Syst Evol Microbiol* **56**, 1917–1920.
- Zhang, X. Y., Zhang, Y. J., Chen, X. L., Qin, Q. L., Zhao, D. L., Li, T. G., Dang, H. Y. & Zhang, Y. Z. (2008). *Myroides profundus* sp. nov., isolated from deep-sea sediment of the southern Okinawa Trough. *FEMS Microbiol Lett* **287**, 108–112.