Renal Replacement Therapy

CASE REPORT

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A case of *Sphingomonas paucimobilis* causing peritoneal dialysis-associated peritonitis and review of the literature

Chiharu Kinoshita*, Koichi Matsuda, Yumiko Kawai, Takayuki Hagiwara and Akane Okada

Abstract

Background: Peritoneal dialysis (PD)-associated peritonitis caused by *Sphingomonas paucimobilis* (*S. paucimobilis*) is very rare, and most of the characteristics of such cases are still unknown.

Case presentation: An 80-year-old Japanese woman on PD was diagnosed with PD-associated peritonitis and received ceftazidime and cefazolin. The number of cells in the peritoneal dialysate decreased quickly. However, because *S. paucimobilis* was detected, the antibiotic was changed to meropenem according to the susceptibility test results. She was treated with meropenem for two weeks and discharged. After 21 days, she was hospitalized for relapsing peritonitis. *S. paucimobilis* was detected again, and improvement after the administration of meropenem was poor, eventually resulting in catheter removal.

Conclusions: *S. paucimobilis* may be resistant to empirical antibiotics; furthermore, catheter removal may still be required, even with sensitive-antibiotic treatment.

Background

Sphingomonas paucimobilis (*S. paucimobilis*) is a non-fermentative Gram-negative bacillus that is widely distributed in nature and is also present in the hospital environment [1, 2]. *S. paucimobilis* rarely infects humans, but when it does, it is suspected to cause meningitis, urinary tract infection, endophthalmitis, splenic abscess, arthritis, osteomyelitis, empyema, pneumonia, and catheter-related infection [2–4]. It has been reported that contaminated solutions, such as distilled water, haemodialysis fluid and sterile drug solutions, cause bacteraemia and sepsis [2]. The pathogenicity of *S. paucimobilis* is considered to be low because the prognosis is generally good despite inappropriate treatment [3]. *S. paucimobilis* infection is most likely to occur in patients complicated with underlying diseases, such as malignant carcinoma, immunodeficiency, or diabetes [3, 4]. The incidence of peritoneal dialysis (PD)-associated peritonitis has decreased due to technological progress [5], but it remains an important complication and a major cause of PD withdrawal [6]. In this report, we present the case of a woman with PD-associated peritonitis caused by *S. paucimobilis* who had to undergo catheter removal and PD withdrawal. Given that studies on *S. paucimobilis*-related peritonitis are rarely reported, this is considered a valuable case.

Case presentation

An 80-year-old Japanese woman developed end-stage renal disease due to nephrosclerosis 2 years previously and started maintenance haemodialysis. Six months later, PD, instead of haemodialysis, was initiated due to remarkably low left heart function. She underwent three-cuff Swan neck catheter implantation. She used an automated connecting device with ultraviolet light undergoing PD. She visited our hospital after experiencing discomfort;

*Correspondence: kinochi3117@gmail.com
Department of Nephrology, Kyoto Miniren Chuo Hospital, 2-1 Tsuchimoto-cho, Uzumasa Ukyo-Ku, Kyoto 616-8147, Japan

she was admitted because of cloudy dialysate and mild abdominal pain starting on the previous day. The dialysis effluent white cell count was 4875/μL, with a predominance of neutrophils (86%), and she was diagnosed with PD-associated peritonitis. On admission, her body temperature was 36.4 ℃, blood pressure was 133/71 mmHg, heart rate was 70/min, height was 155 cm, and weight was 49.9 kg. Only mild abdominal tenderness was noted without muscular defence or rebound tenderness. Diarrhoea was not present. No apparent signs of infection at the exit or in the tunnel were observed. Laboratory findings on admission are summarized in Table 1. Her haemoglobin was 12.2 g/dL, white blood cell (WBC) count was 5600/μL, C-reactive protein was 3.20 mg/dL (normal < 0.3 mg/dL), and albumin was 2.6 g/dL. Blood culture was negative. When 1 g of ceftazidime and 1 g of cefazolin were administered intraperitoneally daily, the dialysis effluent white cell count decreased rapidly. On the fourth day, Gram-negative rods were detected in the peritoneal fluid culture, so only ceftazidime was administered. The causative organism was subsequently identified as *S. paucimobilis*. Given that this organism was resistant to ceftazidime and sensitive to meropenem (Table 2), antibiotic treatment was changed to 0.5 g of intravenous meropenem per day on the seventh day. This dosage was administered for 2 weeks. After the antibiotic was changed to meropenem, the dialysis effluent white cell count was continuously greater than 100/μL, but the neutrophil count in the dialysis effluent was decreased. The neutrophil percentage was 3% on the 18th day. Therefore, we considered meropenem to be effective. The patient was discharged on the 21st day (Fig. 1).

However, three weeks later, the dialysate became cloudy again. The dialysis effluent white cell count was 2604/μL, with a predominance of neutrophils (97%). She was admitted a second time for relapsing peritonitis. On the second admission, her body temperature was 36.7 ℃, blood pressure was 129/73 mmHg, and heart rate was 65/min. As before, mild tenderness was noted throughout the abdomen, without muscle defence or rebound tenderness. No clear signs of infection at the exit tunnel were observed. The haemoglobin level was 10.4 g/dL, WBC count was 5800/μL, C-reactive protein was 2.27 mg/dL, and albumin was 2.5 g/dL (Table 1). From the first day of the second hospitalization, 0.5 g of intravenous meropenem was administered daily. *S. paucimobilis* was detected again in the peritoneal fluid culture during the second admission, and sensitivity testing indicated that it was sensitive to meropenem (Table 2). On the sixth day of the second hospitalization, the dialysis effluent white cell count was 1376/μL. Due to poor improvement, 15 mg of tobramycin was additionally administered intraperitoneally daily. On the ninth day of the second hospitalization, the dialysis effluent white cell count decreased to 337/μL, but we hypothesized that peritonitis was not controlled, because *S. paucimobilis* was detected again in the peritoneal fluid culture on the 6th day. Furthermore, we were worried that the patient was exhausted. On the next day, the PD catheter was removed (Fig. 1). The culture results of the internal cuff, middle cuff, external cuff, catheter between the internal cuff and middle cuff, catheter between the middle cuff and external cuff, and catheter tip were

Table 1 Laboratory data

	First admission	Second admission	
WBC	5600	5800	/μL
RBC	389×10^4	347×10^4	/μL
Hb	12.2	10.4	g/dL
Ht	35.1	30.2	%
MCV	90.2	87.0	fL
Plt	14.9×10^4	18.8×10^4	/μL
Cr	6.88	6.16	mg/dL
BUN	56.6	49.2	mg/dL
BMG	26.6	18.8	mg/L
TP	6.0	5.7	g/dL
Alb	2.6	2.5	g/dL
Na	138	137	mEq/L
K	3.5	3.2	mEq/L
Cl	101	99	mEq/L
Ca	8.4	8.0	mg/dL
P	4.6	3.8	mg/dL
Glu	131	105	mg/dL
ALT	9	10	IU/L
AST	7	6	IU/L
LDH	205	236	IU/L
ALP	384	265	IU/L
γGTP	19	19	IU/L
T.Bil	0.4	0.6	mg/dL
BNP	NA	333.6	pg/mL
CRP	3.2	2.27	mg/dL
Blood culture	–	NA	
Peritoneal WBC	4875	2604	/μL
Neu	86	97	%
Lym	6	2	%
Mon	8	0	%
Eos	0	1	%

WBC, WHITE BLOOD cell count; RBC, red blood cell count; Hb, haemoglobin; Ht, haematocrit; MCV, mean corpuscular volume; Plt, platelet count; Cr, creatinine; BUN, blood urea nitrogen; BMG, β_2 macroglobulin; TP, total protein; Alb, albumin; Glu, glucose; ALT, alanine aminotransferase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase; ALP, alkaline phosphatase; γGTP, γ-glutamyl transpeptidase; T.bil, total bilirubin; BNP, brain natriuretic peptide; CRP, C-reactive protein; Neu, neutrophil; Lym, lymphocyte; Mon, monocyte; Eos, eosinophil

Table2 Culture of peritoneal dialysate, susceptibility (minimum inhibitory concentration, μg/mL)

	First admission	Second admission
Culture of peritoneal dialysate	*S. paucimobilis*	*S. paucimobilis*
Piperacillin	Susceptible (≦8)	Susceptible (≦8)
Ceftazidime	Resistant (> 16)	Resistant (> 16)
Cefepime	Resistant (> 16)	Intermediate (16)
Imipenem/cilastatin	Susceptible (≦1)	Susceptible (≦1)
Meropenem	Susceptible (≦1)	Susceptible (≦1)
Aztreonam	Resistant (> 16)	Resistant (> 16)
Tazobactam/piperacillin	Susceptible (≦8)	Susceptible (≦8)
Gentamicin	Susceptible (≦2)	Susceptible (≦2)
Tobramycin	Susceptible (≦2)	Susceptible (≦2)
Amikacin	Susceptible (≦8)	Susceptible (≦8)
Minocycline	Susceptible (≦2)	Susceptible (≦2)
Levofloxacin	Resistant (> 4)	Resistant (> 4)
Ciprofloxacin	Resistant (> 2)	Resistant (> 2)
Sulfamethoxazole—trimethoprim	Resistant (> 2)	Susceptible (≦2)

negative. She transitioned to haemodialysis, continued to receive meropenem for 15 days after surgery and was discharged.

Discussion and conclusions

S. paucimobilis is an unusual pathogen for PD-associated peritonitis. We report a case of peritonitis due to *S. paucimobilis* that required catheter removal.

Lin et al. reported 42 cases of *S. paucimobilis* bacteraemia [3]. In that study, primary *S. paucimobilis* bacteraemia was found in 35.7% of patients. Catheter-related bloodstream infections were identified in 33.3% of patients, skin and soft tissue infections were identified in 9.5% of patients, pneumonia was identified in 9.5% of patients, urinary tract infections were identified in 4.8% of patients, biliary tract infections were identified in 4.8% of patients, and meningitis was identified in 2.4% of patients. Although three patients experienced septic shock, all 42 patients survived the *S. paucimobilis* bacteraemia episodes. The authors concluded that *S. paucimobilis* exhibited low clinical virulence. *S. paucimobilis* infections other than PD-related peritonitis may not be difficult to treat.

Fourteen cases of PD-associated peritonitis due to *S. paucimobilis* have been reported. The clinical characteristics of this case and the cases reported thus far are summarized in Table 3 [7–19]. The ages of patients ranged from 3.5 to 80 years, and there was no difference in the male-to-female ratio at 7:8. The reports included 2 diabetic patients, 10 nondiabetic patients, and 3 patients with unknown status, and no particular diabetic complications were noted. There were two cases in which the

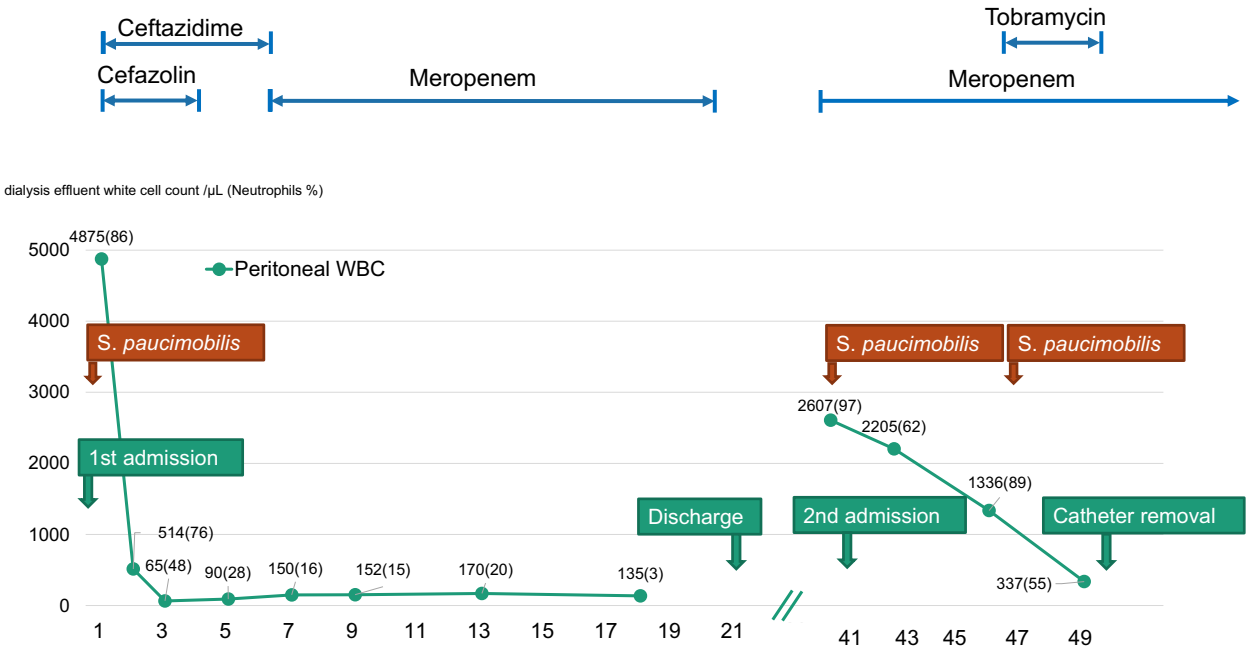

Fig. 1 Clinical course of the present case

Table3 Summary of 15 patients with *Sphingomonas paucimobilis* Peritonitis

Case	Year	Age	Gender	DM	Symptoms (first visit)	Susceptible antibiotics	Treatment	Clinical course	Outcome	References
1	1984	74	Female	No	Abdominal pain Vomiting Cloudy dialysate	ABPC CBPC GM TOB EM TC ST CP	ST IP (14 days)	Rapidly improved	Cured	[7]
2	1984	33	Female	No	Abdominal pain Cloudy dialysate	ABPC CBPC GM TOB EM TC ST CP	1. CEZ IP + TOB IP 2. ABPC IP 3. AMPC orally (5 days) 4. After catheter removal, TOB IV	1 Week after treatment No3, relapsed	Catheter removed	[7]
3	1985	61	Male	No	Cloudy dialysate	CXM CAZ Ticarcillin AMK CP	VCM IP + GM IP (duration NR)	NR	Cured	[8]
4	1985	50	Male	NR	Cloudy dialysate	NR	1. CET IP (4 days) 2. CET IP (5 days) 3. CEX orally (14 days) 4. TOB IP (14 days)	3 Weeks after treatment No1, first relapsed, after 1 week of treatment no. 3, second relapsed	Cured	[9]
5	1987	65	Male	No	NR	MZ CTX	1. VCM (10 days) + TOB (12 days) + ABPC (3 days) 2. MZ (13 days) + CX (13 days) 3. CP (13 days)	NR	Catheter removed	[10]
6	1988	38	Female	No	Cloudy dialysate Abdominal discomfort Nausea	CET TOB	CET IP + TOB IP (duration NR)	4 days after improvement, relapsed	Catheter removed	[11]
7	1990	64	Female	No	Cloudy dialysate	Aminoglycosides ST	1. CPFX orally (5 days) 2. NTL IP(duration NR)	Rapidly improved	Cured	[12]
8	2007	51	Male	Yes	Abdominal pain Fever Cloudy dialysate	CAZ CTX CFPM IPM SBT/CPZ TAZ/PIPC AMK CPFX	1. CEZ + AMK (14 days) 2. CEZ + CAZ (4 days)	12 days after improvement of the first peritonitis due to C. indologenes with treatment of No. 1, developed	Catheter removed	[13]
9	2008	50	Male	NR	Abdominal pain Cloudy dialysate	ABPC PIPC IPM SBT/ABPC SBT/CPZ TAZ/PIPC GM LVFX ST	1. VCM IP, single dose 2. IPM IV + GM IP(18 days) 3. After catheter removal, IPM IV(7 days)	Continued growth of S. paucimobilis despite dialysate without WBCs	Catheter removed	[14]
10	2011	3.5	Male	No	Abdominal pain Fever Cloudy dialysate	MEPM AMK TC PL	1. AMK IP (4 days) 2. MEPM IV	Rapidly improved	Cured	[15]
11	2013	63	Male	Yes	Abdominal pain Cloudy dialysate	CAZ CTX IPM MEPM GM MINO CPFX	1.CEZ IP + CAZ IP(14 days) 2.IPM IP	The next day after treatment of No.1, relapsed Resistant to CAZ	Catheter removed	[16]
12	2015	50	Female	NR	Abdominal pain Vomiting Fever Cloudy dialysate	CFPM MEPM AMK CAM CPFX	1. VCM IP + CPFX IV(1 day) 2. TOB IP + CPFX IV(3 days) 3. TOB IP + MEPM IV(21 days)	Improvement after treatment of No.3	Cured	[17]

Table3 (continued)

Case	Year	Age	Gender	DM	Symptoms (first visit)	Susceptible antibiotics	Treatment	Clinical course	Outcome	References
13	2016	35	Female	No	Abdominal pain Cloudy dialysate	CTRX CFPM IPM CPFX LVFX	1. VCM IP + CAZ IP(3 days) 2. CPFX orally + CTRX IP (21 days) 3. After catheter removal, CPFX orally + CTRX IP (14 days)	3 days after treatment of No.2, relapsed	Catheter removed	[18]
14	2018	63	Female	No	Abdominal pain Vomiting•fever Cloudy dialysate	CAZ AMK GM CPFX	1. CAZ IP + VCM IP (3 days) 2. CAZ IP + AMK IP(21 days)	Rapidly improved	Cured	[19]
This case	80	Female	No	Cloudy dialysate	Table.2	1. CAZ IP (7 days) + CEZ IP(4 days) 2. MEPM IV (14 days) 3. MEPM IV(21 days) TOB IP (2 days)	3 weeks after treatment No2, relapsed	Catheter removed		

DM, diabetes mellitus; ABPC, ampicillin; AMK, amikacin; AMPC, amoxicillin; CAM, clarithromycin; CAZ, ceftazidime; CBPC, carbenicillin; CFPM, cefepime; CPFX, ciprofloxacin; CXM, cefuroxime; CP, chloramphenicol; CEX, cephalexin; CET, cefalotin; CTRX, ceftriaxone; CTX, cefotaxime; CX, cefoxitin; EM, erythromycin; GM, gentamicin; IPM, imipenem; LVFX, levofloxacin, MEPM, meropenem; MINO, minocycline; MZ, mezlocillin; NTL, netilmicin; PL, polymyxin B; SBT/ABPC, sulbactam/ampicillin; SBT/CPZ, sulbactam/cefoperazone; ST, sulfamethoxazole–trimethoprim; TAZ/PIPC, tazobactam/piperacillin; TC, tetracycline; TOM, tobramycin; VCM, vancomycin; IP, intraperitoneally; IV, intravenously; NR, not reported

only symptom was cloudy dialysate; however, most cases were accompanied by abdominal symptoms.

Catheters were removed in 8 of 15 cases. The difference between patients who do versus do not require catheter removal is unclear. However, the unpredictable antibiotic sensitivity pattern of *S. paucimobilis* has been implicated in therapeutic failure [12]. Depending on the antibiotic sensitivity pattern of *S. paucimobilis*, the appropriate treatment can be delayed, which may lead to a refractory infection. Imipenem or meropenem alone and an aminoglycoside plus a third-generation cephalosporin have been suggested as suitable antibiotics for the treatment of infections caused by this organism [15, 20]. However, Bayram et al. reported that 20.0% of bacteria in reported cases were resistant to cefotaxime, and 13.6% were resistant to amikacin [21]. In the present summary, *S. paucimobilis* was sensitive to ceftazidime in a few cases. Regarding empirical treatment of PD-associated peritonitis, selection of third-generation cephalosporins or aminoglycosides is recommended for Gram-negative bacteria [6]. However, it should be noted that *S. paucimobilis* may be resistant to these antibiotics. In the case reported by Lee et al., the bacterium was initially sensitive to ceftazidime, and peritonitis improved, but when it recurred, the bacterium showed resistance to ceftazidime, resulting in catheter removal [16]. Therefore, antibiotic resistance was observed during monotherapy with ceftazidime. Even if *S. paucimobilis* is sensitive to third-generation cephalosporins, the addition of an aminoglycoside to a third-generation cephalosporin may be beneficial. The organism responsible for infection of the patient in the present case was resistant to ceftazidime and sensitive to meropenem. Antibiotic resistance during monotherapy with meropenem was not noted. However, because this bacterium was detected during meropenem administration, the combined use of another antibiotic (e.g. tobramycin) should have been considered when relapse occurred.

In this review, 5 of 8 patients with catheter removal, including the present patient, relapsed after improvement and required catheter removal. Biofilm formation is one of the causes of relapse. Although the culture results of the areas between the cuffs and catheter tip were negative, we suggest that it is possible that a biofilm was formed on the PD catheter in this patient. Nodaira et al. reported that all catheters removed because of PD-associated peritonitis showed biofilms on electron microscopy (EM) scanning; however, patients with catheters removed for other reasons, such as gastrointestinal neoplasm or perforation, did not demonstrate biofilms [22]. EM scanning might have detected a biofilm in the present case. The administration of meropenem was delayed for this patient. Generally, a delay in starting initial antimicrobial therapy can allow pathogens to proliferate, rendering patients less responsive to treatment. Moreover, biofilms that form due to delayed treatment initiation might increase the risk of catheter removal by contributing to the re-development of peritonitis after initiation of treatment [23]. If *S. paucimobilis* is detected and initiation of appropriate treatment is delayed, careful observation is important even after treatment with effective antibiotics because of the risk of relapse.

In this case, the patient was treated with meropenem for only 2 weeks during the first admission because the dialysis effluent white cell count decreased rapidly after cefazolin and ceftazidime were administered, and ceftazidime was administered for one week. The International Society for Peritoneal Dialysis Guidelines (ISPD GL) recommend treating Gram-negative bacilli peritonitis with effective antibiotics for three weeks [6]. Recent studies have reported success in patients who were treated with two antibiotics for three weeks [17, 19]. More than half of the previous reports described failure to eradicate this bacterium, suggesting that two effective antibiotics are needed for three weeks (Table 3).

In summary, we treated a patient with PD-associated peritonitis due to *S. paucimobilis* and summarized and described the cases reported thus far. PD-associated peritonitis due to *S. paucimobilis* is extremely rare, but it is important because catheter removal is often required.

Abbreviations

PD: Peritoneal dialysis; *S. paucimobilis*: *Sphingomonas paucimobilis*; WBC: White blood cell; ISPD GL: International Society for Peritoneal Dialysis Guidelines; UV: Ultraviolet; EM: Electron microscopy.

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Not applicable.

Authors' contributions

CK, KM, YK, TH and AO participated in discussions of the patient's case. CK drafted and is responsible for the final version of the manuscript. All authors read and approved the manuscript and agree with its submission to this journal. All authors read and approved the final manuscript.

Availability of data and materials

All data and materials were included in the manuscript.

Declarations

Ethics approval and consent to participate

This report was written in compliance with the Declaration of Helsinki. For this type of case report, ethics approval is not required.

Consent for publication

Written informed consent was obtained from the patient's family for the publication of this case report.

Competing interests

The authors declare that they have no competing interests.

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