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Case Report

Stenotrophomonas maltophilia: A Case Series and Review for an Uncommon Cause of Peritoneal Dialysis-Associated Infection

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Abstract: Peritonitis is a common and potentially serious complication of peritoneal dialysis (PD). Common organisms include *Staphylococcus Aureus*, enterococci, and coagulase-negative staphylococcus. However, *Stenotrophomonas maltophilia* (*S. maltophilia*) is an uncommon cause of PD-related infection. We describe a series of three cases of *S. maltophilia* PD infection (two cases of PD peritonitis and one case of PD exit-site infection) that were identified over a seven-week period in a single centre. The cases were treated with antibiotics (the primary antibiotic being co-trimoxazole) for a mean duration of 30 ± 7.9 days. All of the patients required PD catheter removal due to treatment failure with antibiotics. Hospital admission was required in two of the cases and one case resulted in mortality, with the cause of death directly associated with complications from *S. maltophilia* infection. A multi-disciplinary team using root-cause analysis did not identify a common link between our cases but highlighted possible risk factors contributing to these presentations. Given the relative rarity of *S. maltophilia*, evidence on its management options remains limited. In this article, we draw upon our own experiences and examine the literature available from previously published case reports and series. These reports highlight *S. maltophilia* as a complex and challenging organism to treat. Our experience demonstrated the importance of early PD catheter removal in *S. maltophilia* PD infection, as this is likely more effective than prolonged antibiotic therapy and hence a safer management option, considering the resistant nature of *S. maltophilia*.

Keywords: peritoneal dialysis; Peritonitis; *Stenotrophomonas maltophilia*; intraperitoneal antibiotics; PD catheter removal

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1. Introduction

Peritonitis is a common and potentially serious complication of peritoneal dialysis (PD), however infections such as *Stenotrophomonas maltophilia* (*S. maltophilia*) is an uncommon cause. *S. maltophilia* is a gram-negative bacillus which was previously part of the Pseudomonas genus before it was classified with its own genus, where *S. maltophilia* is the only recognized species [1]. *S. maltophilia* infections are considered opportunistic and commonly but not exclusively occur in immunosuppressed patients. *S. maltophilia* is frequently found in water sources and forms biofilms, making it difficult to treat. Hospital sources of *S. maltophilia* include respiratory ventilators, hospital suction tubing, and water dispensers [2]. It is an important cause of nosocomial infections [3,4].

Treatment with antibiotics is often unsuccessful due to the resistance of *S. maltophilia* towards many antimicrobial classes [3]. Optimal dosing of trimethoprim–sulfamethoxazole (also known as co-trimoxazole) is the mainstay of treatment but remains limited in its effectiveness towards such infections. Complications of *S. maltophilia* PD infection may

include recurrent infections, dependence on long-term haemodialysis (HD) following PD catheter removal, and mortality [3–12].

2. Case Report

Three cases of *S. maltophilia* PD infection were identified in our centre over a span of 7 weeks. Whilst the centre met the International Society of Peritoneal Dialysis (ISPD) recommendations of <0.40 episodes per year, these cases accounted for 12.5% (2 out of 16) of our centre's total PD peritonitis cases in 2019. The three case patients had dialysis-dependent kidney failure as well as co-morbidities including diabetes mellitus and hypertension. All three case patients were receiving continuous ambulatory peritoneal dialysis (CAPD) at home. These patients were each under the care of different specialist PD nurses and were seen routinely in the outpatient clinic by consultant nephrologists. There were no recent hospital admissions or intra-abdominal procedures, but all three patients had been receiving oral antibiotics for non-*S. maltophilia* PD infection before presenting. In the U.K., microbiology samples in the community are taken, on average, one day following the onset of symptoms. The *S. maltophilia* isolated in each of the cases were resistant to all antibiotics (excluding co-trimoxazole), and the three case patients had a mean antibiotic administration duration of 30 $\pm$ 7.9 days.

2.1. Case One

Case one was a 53-year-old man who had been on CAPD for 13 months secondary to diabetic nephropathy. His most recent Kt/V was 1.76 and he was achieving good clearance on four daily exchanges of 2.5 L fills with 1.36% and 2.27% dextrose bags and a final fill of icodextrin. He was a diabetic with poor glycaemic control who previously had one episode of culture-negative PD peritonitis 9 months prior to his presentation with *S. maltophilia*. The initial episode of culture-negative PD peritonitis was treated empirically with intraperitoneal (IP) antibiotics. In addition, he had three episodes of *Staphylococcus Aureus* (*S. Aureus*) PD exit-site infection and had completed a course of flucloxacillin for this 6 weeks prior. The patient presented with discharge from his exit site which was swabbed twice and found to be positive for *S. maltophilia.* He was managed as an outpatient provided he was clinically well and treated with IP co-trimoxazole for 2 weeks. Despite the antibiotic treatment, the exit-site culture remained positive and he later underwent PD catheter removal and permanent conversion to haemodialysis (HD) 21 days following presentation with *S. maltophilia* PD infection.

2.2. Case Two

Case two was a complex case—a 49-year-old lady with a background of kidney failure secondary to IgA nephropathy, hypertension, and a rare genetic neurological and developmental disorder. The patient had been receiving PD for several years and had previously had one episode of a *S. Aureus* PD exit-site infection which was fully treated 18 months prior to this presentation with *S. maltophilia.* The patient had recently been treated with oral antibiotics in the community for a sensitive *Escherichia Coli* urinary tract infection. Dialysis adequacy was satisfactory and she had a normal serum albumin and parathyroid hormone at time of infection. Her PD prescription included 2L fills with 1.36% dextrose bags. She presented with abdominal pain and vomiting, and the PD fluid culture confirmed *S. maltophilia*-related PD peritonitis. Given the complexity of the patient's underlying health conditions, she was admitted for inpatient treatment in an attempt to salvage the catheter with antibiotics. Despite treatment with multiple antibiotics including IP co-trimoxazole, IP gentamicin, intravenous (IV) cefuroxime, metronidazole, and teicoplanin, the patient continued to become unwell, and the catheter was removed. Following family and multi-disciplinary team discussions, the patient was not felt to be suitable for conversion to HD, and a PD catheter was reinserted 2 weeks later. Shortly after this, the patient developed respiratory compro-

mise from fluid overload secondary to poor ultrafiltration, alongside hospital-acquired pneumonia, and she later died from sepsis.

2.3. Case Three

Case three was a 48-year-old lady who had a background of kidney failure secondary to systemic lupus erythematosus (SLE) with lupus nephritis (Class V) as well as hypertension and renal bone disease. She had been on CAPD for 7 months prior to *S. maltophilia* infection, receiving three exchanges a day of 1.36% dextrose, 2L fills, and achieving a Kt/V of 2.1. The patient had been treated for a simple respiratory tract infection with amoxicillin several weeks prior to developing PD peritonitis with no previous episodes of PD-related infections reported. Five months prior to this, the patient had experienced a severe relapse of SLE with extra-renal involvement and was treated with a total of 2 grams of cyclophosphamide, 1 gram of rituximab, as well as high-dose intravenous methylprednisolone. The patient initially presented with cloudy PD fluid and was commenced on outpatient IP co-trimoxazole. Despite treatment with appropriate antibiotic therapy, the PD cultures remained positive for *S. maltophilia.* There was some delay in the PD catheter being removed due to the patient being away on holiday. During this time, she developed features of systemic infection, abdominal pain, and fevers. She was admitted to hospital for urgent PD catheter removal and washout in theatre. She was later commenced on HD and remains currently well on this.

3. Discussion

S. maltophilia PD infection is a severe infection that, whilst uncommon, may have catastrophic consequences. We conducted a systematic search of previously published case reports and series of *S. maltophilia* PD infection using the search terms: "Stenotrophomonas maltophilia", "Peritoneal Dialysis", "Infection", "Peritonitis", "Exit site Infection", and others into search engines, including PubMed, Web of Science, EMBASE, Google Scholar, and Medline-ProQuest. Only publications in the English language were included. Including our case series, there were a total of 11 publications—five case series and six single case reports totalling 30 patients presenting with *S. maltophilia* PD infection between 1999 and 2021 (Table 1) [3–12].

Table 1. Summary of published case reports and case series in patients with *S. maltophilia* PD infection.

Author, Year of Publication, Journal, Country	Case Report or Case Series	Number of Patients	Sex (M: F)	Mean Age of Patients (Years)	Pre-Existing Diabetes or Immunosuppression	CAPD or APD	Mean Length of Time between Cases	Peritonitis: Exit Site Infections	Antibiotic Regimen Received	Patient Outcomes—PD Catheter Removal, Switch to HD, and Recurrent Infection
Taylor et al. [5] 1999 Canada	Case series	7	3:4	38	one diabetic patient, two receiving immunosuppression	All patients received CAPD	2 years	7:0	All patients received co-trimoxazole, chloramphenicol, and tazocin	Four of seven patients had PD catheter removal. One patient was transferred to HD. Two patients had catheter re-inserted. One patient did not require further dialysis as kidney failure resolved. The other three patients without catheter removal continued PD without recurrent infection
Al-Hilali et al. [6] 2000 Kuwait	Case series	4	3:1	56	All of the patients are diabetic	All patients received CAPD	7 years	2:2	All patients received co-trimoxazole, vancomycin, and amikacin	Three of four patients had PD catheter removal. Two patients were transferred to HD. One patient had catheter re-inserted following treatment of infection. The other patient without catheter removal continued PD without recurrent infection
Baek et al. [4] 2004 Korea	Case series	5	2:3	51	There are three diabetic patients	All patients received CAPD	3 years	3:2	All patients received co-trimoxazole, cefazolin, and vancomycin	One of five patients had PD catheter removal. That patient also developed fungal peritonitis and was switched to HD. The other four patients without catheter removal continued PD. One patient was lost to follow-up. There were no recurrent infections reported for the other three patients

Table 1. *Cont.*

Author, Year of Publication, Journal, Country	Case Report or Case Series	Number of Patients	Sex (M: F)	Mean Age of Patients (Years)	Pre-Existing Diabetes or Immunosuppression	CAPD or APD	Mean Length of Time between Cases	Peritonitis: Exit Site Infections	Antibiotic Regimen Received	Patient Outcomes—PD Catheter Removal, Switch to HD, and Recurrent Infection
Tzanetou et al. [7] 2004 Greece	Case series	5	2:3	60	Nil	All patients received CAPD	4 years	5:0	All patients received co-trimoxazole, vancomycin, and Amikacin	One of five patients had PD catheter removal. That patient had a catheter re-inserted following treatment of Infection. The other four patients without catheter removal continued PD. There were no recurrent infections reported
Machuca et al. [8] 2005 Chile	Case report	1	F	54	Nil	APD	-	Peritonitis	Co-trimoxazole and amikacin	Did not require PD catheter removal. Continued PD with no further recurrent infections reported
Azak et al. [9] 2011 Turkey	Case report	1	F	57	Patient is diabetic	CAPD	-	Peritonitis	Ceftazidime, vancomycin, and levofloxacin	Did not require PD catheter removal. Patient continued PD following discharge but not specified whether there were further recurrent infections
Kusaba et al. [10] 2012 Japan	Case report	1	M	66	Nil	Not specified	-	Peritonitis	Ceftazidime, vancomycin, prior to commencement on co-trimoxazole	Patient had PD catheter removed during inpatient stay and was switched to HD
Ma et al. [11] 2012 Taiwan	Case report	1	F	41	Patient is not diabetic and was not on immunosuppression. However, she had CIN grade III and underwent cervical conization and endocervical curettage under colposcopy 2 weeks prior to presentation	CAPD	-	Peritonitis	Cefazolin, gentamicin, and ciprofloxacin	Did not require PD catheter removal. Patient continued PD but not specified whether there were further recurrent infections

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Author, Year of Publication, Journal, Country	Case Report or Case Series	Number of Patients	Sex (M: F)	Mean Age of Patients (Years)	Pre-Existing Diabetes or Immunosuppression	CAPD or APD	Mean Length of Time between Cases	Peritonitis: Exit Site Infections	Antibiotic Regimen Received	Patient Outcomes—PD Catheter Removal, Switch to HD, and Recurrent Infection
Millán-Díaz et al. [3] 2017 Spain	Case report	1	Sex not specified	54	On immunosuppression post-lung transplantation	APD	-	Three episodes of recurrent Peritonitis	Vancomycin, ceftazidime, fluconazole prior to commencement of co-trimoxazole	Patient had PD catheter removed during inpatient stay and was switched to HD
Thabet et al. [12] 2021 Tunisia	Case report	1	Female	44	Nil	CAPD	-	Peritonitis	Ceftazidime, gentamicin, fluconazole prior to commencement of co-trimoxazole	Patient had PD catheter removed during inpatient stay and was switched to HD
Floyd et al. 2022 UK	Case series	3	1:2	50	1 diabetic patient, 1 receiving immunosuppression	CAPD	7 weeks	2:1	All patients received co-trimoxazole. One case also received gentamicin, cefuroxime, metronidazole, and teicoplanin.	All three patients had PD catheter removed. One patient unfortunately succumbed to mortality during acute admission whilst the other two patients were switched to HD
Aggregate Data Summary	Five Case Series; Six Case Reports	30 patients	M:F = 12:17 (1 patient gender not specified) %M = 41.4 %F = 58.6	Mean ± SD = 50.4 ± 8.8	Ten diabetic patients; four patients received immunosuppression. %Diabetic = 33.3 %Immunosuppressed = 13.3	CAPD: APD = 27:3 %CAPD = 90 %APD = 10	N/A	Peritonitis: Exit Site Infections = 25:5 %Peritonitis = 83.3 %Exit Site Infections = 16.7	Twenty-eight patients received co-trimoxazole %Patients on Co-trimoxazole = 93.3	Removed PD Catheter: Retained PD Catheter = 15:15 %Removed PD Catheter = 50 %Retained PD Catheter = 50 Continued/restarted on PD post-infection: Transferred to HD = 21:9 %Continued/restarted on PD post-infection = 70 %Transferred to HD = 30

APD: automated peritoneal dialysis; CAPD: continuous ambulatory peritoneal dialysis; CIN: cervical intraepithelial neoplasia; F: female; HD: haemodialysis; M: male; SD: standard deviation; UK: United Kingdom.

In the 10 publications (27 cases) gathered from our systematic literature search, there were 15 females and 11 males (one case did not specify patient gender). The mean age was 52 years. Five publications documented patients who had pre-existing diabetes mellitus, and two publications reported patients who received long-term immunosuppression. As our three cases did, 24 of 27 patients received CAPD (the other three cases received automated peritoneal dialysis (APD)). Whether it can be alluded to that CAPD is a contributing factor towards *S. maltophilia* remains debatable. Whilst there were several randomized control trials which found, on the contrary, that APD patients are at higher risk of peritonitis than CAPD patients, there remain no definitive study which has found any significant association between PD modality and peritonitis risk [13,14].

Amongst the four published case series, the reported cases occurred over a mean period of over 4 years, which is in stark contrast to our case series in which the three cases occurred within a space of 7 weeks. This raises the possibility of a nosocomial infective source.

Locally, we undertook several root-cause analysis meetings that were attended by multiple specialists including nephrologists, microbiologists, and specialist nursing staff. Multiple risk factors and potential sources of the organism were explored. One possibility to consider is whether preceding infections and associated antibiotic treatments predisposed our three cases to *S. maltophilia* PD infections, similar to what is seen when antibiotic treatments for routine bacterial peritonitis predisposed patients to subsequent fungal peritonitis. Otherwise, no clear explanation for the proximity of these presentations was established. Two of the three patients were managing their PD independently at home, with little community support from the specialist PD nurses. All of their PD competencies and training had been completed within 3 months prior to them having *S. maltophilia* infection. One patient was receiving assisted CAPD and had the same PD specialist nurses throughout treatment who were up to date on all training requirements. Each patient was visited by a different specialist nurse to assess handwashing and aseptic techniques following the cluster outbreak with no concerns reported around aseptic technique. None of the patients reported a change to their environmental situation and none had pets at home. One patient previously had issues with water stagnation at a mobile home site which was a potential contributing factor, but the water quality was not identified as an issue on this occasion. Other contributing factors including infection stemming from the dialysate fluid and equipment were explored. Different types of dialysates were used with unique batch numbers. The dialysate fluids for all of the cases were delivered in three to four monthly deliveries which is our centre's standard practice. The timing of these deliveries were different and all storage units were deemed satisfactory, meeting our local policy criteria. The dialysate fluid bags were all in date and there were no reported issues from the manufacturer. Information on molecular typing to detect clonal relatedness and strain characterization to verify the strain relationships of the *S. maltophilia* was not available.

In terms of *S. maltophilia* PD infection management, 8 of the 10 publications noted the use of co-trimoxazole as the eventual primary antibiotic therapy in combination with other antibiotic and/or antifungal agents, in similarity with the antibiotic regimen for two of our three cases. This is in line with the updated 2022 ISPD guidelines on PD peritonitis management, which advises the prescription of co-trimoxazole as the primary antibiotic, combined with at least another class of antibiotic for at least 3 weeks in *S. maltophilia* PD peritonitis [15]. A total of 12 of the 27 patients required PD catheter removal due to the inability of antibiotic treatment to resolve the infection or prevent infection recurrence, and seven patients eventually transferred to HD permanently. Whilst specific guidance for PD catheter removal in *S. maltophilia* PD infections is lacking, the current ISPD guideline on PD peritonitis updated from the previous version advises consideration of expectant management in patients for longer than 5 days if PD effluent white cell count is decreasing towards normal, instead of mandatory PD catheter removal if effluent does not clear up by day five [15,16]. Considering improved clinical outcomes in all of the published cases with

no reports of acute mortality, it is suggestive that PD catheter removal and transition to HD may remain the appropriate option in the setting of refractory or recurrent *S. maltophilia* PD infection. Extended courses of antibiotics are required but may not be fully successful as the definitive treatment to resolve *S. maltophilia* PD infections. Left untreated, patients will have poor outcomes with prolonged hospitalizations, its associated complications, and fatality. Given the limitation in the available data at present, further reports and evaluation of cases relating to *S. maltophilia* PD infection would be needed for more directive guidance regarding antibiotic and PD catheter management going forward.

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References

1. Palleroni, N.J.; Bradbury, J.F. Stenotrophomonas, a new bacterial genus for Xanthomonas maltophilia (Hugh 1980) Swings et al. 1983. *Int. J. Syst. Evol. Microbiol.* **1993**, *43*, 606–609. [CrossRef] [PubMed]
2. Brooke, J.S. Stenotrophomonas maltophilia: An emerging global opportunistic pathogen. *Clin. Microbiol. Rev.* **2012**, *25*, 2–41. [CrossRef]
3. Millán-Díaz, B.; González-Tabarés, L.; Cobelo-Casas, C.; López-Vázquez, M.; Calviño-Varela, J. Stenotrophomonas maltophilia: A rare cause of peritonitis in CAPD patients. *Nefrologia* **2017**, *37*, 646–647. [CrossRef]
4. Baek, J.E.; Jung, E.Y.; Kim, H.J.; Lee, G.W.; Hahm, J.R.; Kang, K.R.; Chang, S.H. Stenotrophomonas maltophilia infection in patients receiving continuous ambulatory peritoneal dialysis. *Korean J. Intern. Med.* **2004**, *19*, 104–108. [CrossRef]
5. Taylor, G.; McKenzie, M.; Buchanan-Chell, M.; Perry, D.; Chui, L.; Dasgupta, M. Peritonitis due to Stenotrophomonas maltophilia in patients undergoing chronic peritoneal dialysis. *Perit. Dial. Int.* **1999**, *19*, 259–262. [CrossRef] [PubMed]
6. Al-Hilali, N.; Nampoory, M.R.; Johny, K.V.; Chugh, T.D. Xanthomonas maltophilia infection in chronic peritoneal dialysis patients. *Scand. J. Urol. Nephrol.* **2000**, *34*, 67–69. [CrossRef] [PubMed]
7. Tzanetou, K.; Triantaphillis, G.; Tsoutsos, D.; Petropoulou, D.; Ganteris, G.; Malamou-Lada, E.; Ziroyiannis, P. Stenotrophomonas maltophilia peritonitis in CAPD patients: Susceptibility to antibiotics and treatment outcome: A report of five cases. *Perit. Dial. Int.* **2004**, *24*, 401–404. [CrossRef] [PubMed]
8. Machuca, E.; Ortiz, A.M.; Rabagliati, R. Stenotrophomonas maltophilia peritonitis in a patient receiving automated peritoneal dialysis. *Adv. Perit. Dial.* **2005**, *21*, 63–65. [PubMed]
9. Azak, A.; Kocak, G.; Huddam, B.; İşcan, G.; Duranay, M. An unusual cause of continuous ambulatory peritoneal dialysis-associated outpatient peritonitis: Stenotrophomonas maltophilia. *Am. J. Infect. Control* **2011**, *39*, 618. [CrossRef] [PubMed]
10. Kusaba, T.; Kirita, Y.; Ishida, R.; Matsuoka, E.; Nakayama, M.; Uchiyama, H.; Kajita, Y. Morphological analysis of biofilm of peritoneal dialysis catheter in refractory peritonitis patient. *CEN Case Rep.* **2012**, *1*, 50–54. [CrossRef] [PubMed]
11. Ma, T.L.; Wang, C.T.; Hwang, J.C. Recurrent peritonitis episodes in a continuous ambulatory peritoneal dialysis patient after gynecologic procedures. *Perit. Dial. Int.* **2012**, *32*, 113–114. [CrossRef] [PubMed]
12. Thabet, N.; Guedri, Y.; Ajimi, K.; Zellama, D.; Fradi, A.; Aicha, N.B.; Sahtout, W.; Mrabet, S.; Azzabi, A.; Achour, A. POS-670 Severe Stenotrophomonas maltophilia peritonitis in a patient receiving peritoneal dialysis. *Kidney Int. Rep.* **2021**, *6*, S292. [CrossRef]
13. Oo, T.N.; Roberts, T.L.; Collins, A.J. A comparison of peritonitis rates from the United States Renal Data System database: CAPD versus continuous cycling peritoneal dialysis patients. *Am. J. Kidney Dis.* **2005**, *45*, 372–380. [CrossRef] [PubMed]
14. Lan, P.G.; Johnson, D.W.; McDonald, S.P.; Boudville, N.; Borlace, M.; Badve, S.V.; Sud, K.; Clayton, P.A. The association between peritoneal dialysis modality and peritonitis. *Clin. J. Am. Soc. Nephrol.* **2014**, *9*, 1091–1097. [CrossRef] [PubMed]

15. Li, P.K.; Chow, K.M.; Cho, Y.; Fan, S.; Figueiredo, A.E.; Harris, T.; Kanjanabuch, T.; Kim, Y.L.; Madero, M.; Malyszko, J.; et al. ISPD peritonitis guideline recommendations: 2022 update on prevention and treatment. *Perit. Dial. Int.* **2022**, *42*, 110–153. [CrossRef] [PubMed]
16. Li, P.K.; Szeto, C.C.; Piraino, B.; de Arteaga, J.; Fan, S.; Figueiredo, A.E.; Fish, D.N.; Goffin, E.; Kim, Y.L.; Salzer, W.; et al. ISPD peritonitis recommendations: 2016 update on prevention and treatment. *Perit. Dial. Int.* **2016**, *36*, 481–508. [CrossRef] [PubMed]