Case Report

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Prolonged suppressive antibiotic therapy for inferior vena cava filter infection following emphysematous pyelonephritis and cystitis: a case report

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Introduction and importance: Infections of inferior vena cava (IVC) filters are rare. The authors present a case of IVC filter infection following concurrent emphysematous urinary tract infections that was finally treated with prolonged suppressive antibiotic therapy (PSAT).

Case presentation: A 68-year-old man with pemphigoid and type 2 diabetes mellitus, who had undergone IVC filter placement, was transferred with decreased consciousness, respiratory failure, and hypotension. Computed tomography revealed gas in the left renal parenchyma and bladder wall, suggesting a diagnosis of concurrent emphysematous pyelonephritis and cystitis. While blood and urine cultures were positive for extended-spectrum beta-lactamase-producing *Escherichia coli*, and the patient's general condition improved with proper antibiotic therapy, bacteremia persisted until day 10 from symptom onset. After ruling out abscesses and infectious endocarditis, the cause of persistent bacteremia was suspected to be IVC filter infection. As the IVC had been placed 12 years before, the authors did not remove it to avoid complications. PSAT with sulfamethoxazole-trimethoprim was continued after 6 weeks of intravenous antibiotic therapy. The patient had an uneventful course over the year following hospital discharge.

Clinical discussion: PSAT is considered for device-related infections in patients with cardiac assist devices and artificial joints when the infection flares up or recurs even after antibiotic treatment of an adequate duration. There is no consensus regarding the optimal duration of antimicrobial therapy for IVC filter infections.

Conclusion: Infections of implanted devices, such as IVC filters, secondary to severe infections can cause persistent bacteremia. PSAT may be an alternative option to treat IVC filter infection, when the IVC filter is considered difficult to remove.

Keywords: bacteremia, prolonged suppressive antibiotic therapy, urinary tract infections, vena cava filters

Introduction

The basis of treating infection is controlling the source (source control) and antimicrobial therapy. However, source control could sometimes be challenging in device-related infections such as left ventricular assist device infections and prosthetic joint infections[1,2]. In such cases, prolonged antibiotic suppression therapy (PSAT) has been used to treat infections of devices that are difficult to remove.

HIGHLIGHTS

- Inferior vena cava (IVC) filter infection is rare.
- Prolonged suppressive antibiotic therapy (PSAT) is considered for device-related infections in patients with cardiac assist devices and artificial joints.
- There is no consensus on the optimal duration of antimicrobial therapy for IVC filter infections.
- We successfully treated an IVC filter infection secondary to urinary tract infections with PSAT.
- PSAT may be an option to treat IVC filter infection, if the filter is considered difficult to remove.

Inferior vena cava (IVC) filters have been used worldwide to prevent pulmonary embolism since 1967[3]. Only a few studies have reported infection of IVC filters, and most of the reported cases were treated with the removal of the IVC filters. However, it could be difficult to remove the filter due to its suspected adhesion to the vascular wall if the infection occurs long after its placement. Herein, we describe a case of persistent gram-negative rod (GNR) bacteremia and suspected IVC filter infection following concurrent emphysematous urinary tract infections (UTIs) for which PSAT was administrated. We present this article in accordance with the SCARE 2023 guidelines[4].

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Case presentation

A 68-year-old nursing-home-dwelling man was admitted to a hospital with decreased consciousness, tachypnea, hypoxia, and hypotension. The patient had reportedly experienced haematuria the previous day. He was on several hypoglycaemia medications, including dapagliflozin, for type 2 diabetes mellitus; and had urinary disturbance after a Th10-level traumatic spinal cord injury with lesions. Other medical history included pemphigoid, for which oral prednisolone 7 mg/day was administered for years. The patient also underwent IVC filter placement 12 years before (Fig. 1). On admission, the patient's vital signs were as follows: pulse rate, 100 beats/min; blood pressure, 78/32 mmHg; respiratory rate, 42 breaths/min; peripheral oxygen saturation, 95% (reservoir 10 l); and Glasgow Coma Scale score, 12 (E3V4M5). Physical examination revealed glossoptosis due to decreased consciousness and bilateral coarse crackles. No significant abdominal abnormalities were observed. Laboratory evaluation yielded elevation in white blood cell count (20 100/μl; reference value, 3300–8600 /μl), C-reactive protein (22.26 mg/dl; reference value <0.14 mg/dl), and serum lactate (reference 5.3 mmol/l; reference value, 0.56–2.2 mmol/l). Urinalysis revealed pyuria and bacteriuria. Contrast-enhanced computed tomography (CT) revealed gas in the bladder wall, left renal pelvis, renal parenchyma, and ureter (Fig. 2). Septic shock due to emphysematous pyelonephritis (EPN) and cystitis (EC) was diagnosed according to the Third International Consensus Definitions for Sepsis and Septic Shock[5]. In addition to intravenous norepinephrine, meropenem (0.5 g) was intravenously administered every 8 h. Nevertheless, the patient was hemodynamically unstable and was referred to us 2 days after hospitalization.

The patient was admitted to our intensive care unit and intubated for profound shock. Echocardiography revealed favourable cardiac contractions without valvular abnormalities. Extracellular fluid load and hydrocortisone (200 mg/day) were required to maintain blood pressure, in addition to norepinephrine (0.75 mcg/kg/min) and vasopressin (1.4 units/h). A prolonged meropenem dose (1 g every 8 h over 4 h) was administered for the severe infections. Since no apparent abscess formation or massive gases were present on the CT, we avoided percutaneous drainage of the EPN or EC.

Extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* was detected in blood and urine cultures collected on hospital days 3 and 5. We attempted to identify the source of persistent bacteremia; however, no renal abscess was detected on repeat contrast-enhanced CT. Based on the persistent bacteremia and high fever, a possible diagnosis of infectious endocarditis (IE) was made using Duke's criteria; however, no vegetation was observed on the cardiac valves on transesophageal echocardiography. IVC filter infection was the remaining differential diagnosis. Given a potential filter-to-IVC adhesion, we retained the IVC filter to avoid complications. Based on the culture results, meropenem was changed to cefmetazole (2 g every 8 h) and amikacin (800 mg every 24 h) 3 days after hospital admission. The patient's general condition improved, and he was extubated on hospital day 7 and discharged from the intensive care unit the next day. Blood cultures obtained on hospital day 8 (10 days from symptom onset) were finally confirmed to be negative. We administered antibiotics for at least 6 weeks to treat possible IE. On hospital day 27, intravenous amikacin was changed to oral sulfamethoxazole-trimethoprim (400 mg sulfamethoxazole and 80 mg trimethoprim, every 24 h). Cefmetazole was discontinued at 6 weeks, and PSAT with oral sulfamethoxazole-trimethoprim was continued for presumptive IVC filter infection. Sulfamethoxazole-trimethoprim was subsequently adjusted to every 48 h due to hyperkalemia. The patient was discharged on hospital day 43 and had an uneventful course for 18 months when he died with pneumonia.

Discussion

Our patient presented with persistent GNR bacteremia and suspected IVC filter infection following emphysematous UTIs. While IE is an important differential diagnosis of persistent GNR bacteremia, after ruling out abscesses, no evidence was present to support a diagnosis of IE in our case. Thus, IVC filter infection was suspected.

Emphysematous UTIs are potentially fatal. The pathogenesis of increased gas production in these infections may be rapid catabolism and impaired end-product transport[6]. *E. coli* is the predominant causative organism, followed by *Klebsiella pneumonia* and *Proteus*[7,8]. Although emphysematous UTI is relatively rare, co-infection with EC and EPN is scarcely reported[9,10]. The risk

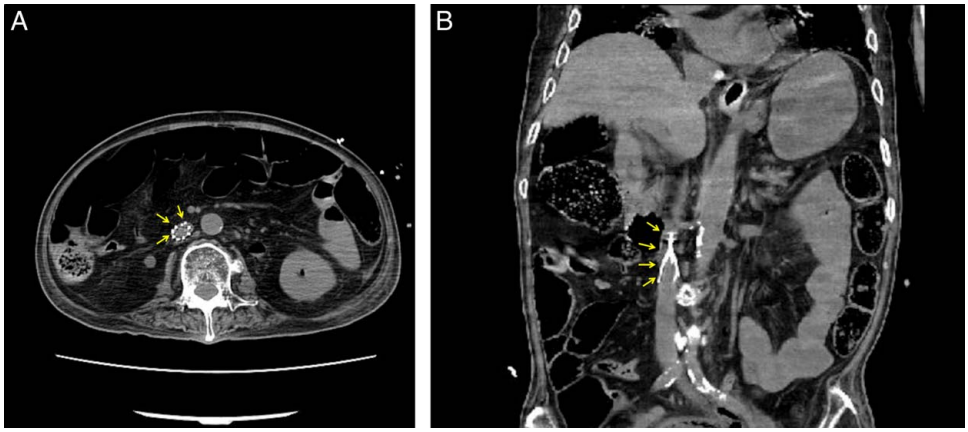

Figure 1. The presence of inferior vena cava filter on an axial (A) and coronal (B) view of computed tomography.

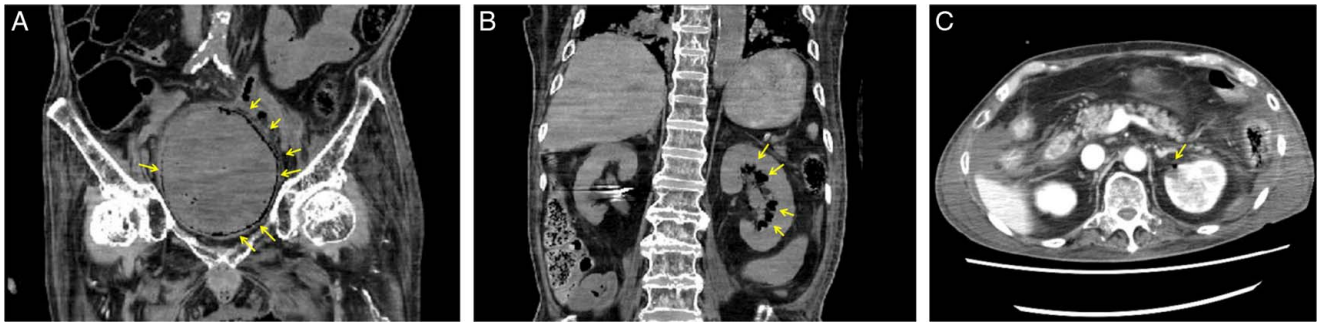

Figure 2. Computed tomography showing intramural emphysema of the bladder (A), gas in the left renal pelvis (B), and renal parenchyma (C).

factors for emphysematous UTIs include age, female sex, diabetes mellitus, and urinary tract obstruction[6]. Particularly, high tissue-glucose concentrations and reduced immunity in patients with diabetes mellitus potentially facilitate gas-forming microbial development[6]. This patient had a high morbidity risk owing to long-standing type 2 diabetes mellitus and bladder and bowel dysfunction.

Treatment for concurrent EC and EPN has not yet been established. Nevertheless, previous case reports have complied with the following options: antimicrobial agents alone, antimicrobial agents plus cystectomy or nephrectomy, or antimicrobial agents plus percutaneous drainage[7]. In our case, we selected antimicrobial agent therapy alone because (1) no drainable lesion, such as an abscess in the kidney, bladder, or other organ, was present despite the presence of persistent bacteremia; and (2) the patient's general condition, including circulatory status, continued to improve.

IVC filter infection is also rare. To our knowledge, four articles reporting six cases of this infection have been published in English (Table 1)[11–14]. All six cases presented with nonspecific symptoms, such as mild fever. Time of infection from IVC filter implantation ranged from 2 days to a year. No consensus or established criteria for diagnosing IVC filter infection exist. Two cases were diagnosed using positron emission tomography-computed tomography (PET/CT)[12], another two by IVC filter positive cultures[11,13], and another by culture of IVC wall[14]. The other case was diagnosed based on lack of potential infection source and improvement in fever and inflammatory response after IVC filter removal[12]. The reported causative microorganisms are *Staphylococcus aureus*, coagulase-negative Staphylococcus, and *Candida* species. Ours was the first case of infection after 12 years following IVC filter implantation and the first GNR-induced IVC-filter-infection case.

Pathogenesis of IVC filter infection is not clearly demonstrated. However, it could be postulated from infection of other vascular graft infection: contamination or colonization of the IVC filter with bacteria that entered the bloodstream during placement of the filter, contamination from adjacent infected areas, and secondary bloodstream infection originating from an anatomically remote organ. In our case, considering the timing of IVC filter insertion and absence of active infective sources based on diagnostic imaging, the pathogenesis of his IVC filter infection might be a secondary bloodstream infection from UTIs.

We supported the diagnosis of IVC filter infection in this patient for several reasons. First, no other suspected source for persistent bacteremia was detected. Similar to previous cases of IVC filter infection, we ruled out abscesses and IE based on contrast-enhanced CT and transesophageal echocardiography, respectively. Second, persistent bacteremia, despite the primary source of infection being controlled, is rare[15]. In a study of follow-up blood cultures after appropriate antimicrobial treatment for GNR-induced UTI, persistent bacteremia for over a week was observed in only 3.3% of the patients[16]. Since this patient's EC and EPN had been effectively controlled with antibiotics for over a week, we considered the persistent bacteremia to be due to other infection sources, and the sole uninvestigated aetiology was IVC filter infection. ESBL-producing *E. coli* was identified in the patient's urine and blood upon admission, and persistent bacteremia was due to an identical microorganism. Since the primary source, that is, concurrent EC and EPN, had been well controlled, IVC filter infection should have occurred secondarily.

There is insufficient evidence on the necessity of device removal in cases of IVC filter infection. Removing infected stents is generally advocated but is difficult in cases of peripheral vascular stent infection[17]. A case series revealed that five cases of arterial endovascular stent infection were treated with antimicrobial therapy alone[18]. Furthermore, two cases of IVC filter infection were also treated with antimicrobial therapy alone[12]. In our case, filter-to-IVC adhesion due to long-term implantation was a concern. Although further validation is required, device retention in high-risk patients may be an option.

There is no consensus regarding the optimal duration of antimicrobial therapy for IVC filter infections. In previous cases of IVC filter infection, the duration was 10 days–6 weeks in cases of IVC filter removal and 6 weeks in cases of IVC filter retention. GNR-induced IE is rare and its prognosis is poor[19]. In our patient, we conservatively evaluated the risk of complicated IE and administered antibiotics for 6 weeks for possible GNR-induced IE[20]. After completing treatment for IE, PSAT was administered for IVC filter infection, which was more likely than IE. No studies have reported the use of PSAT for IVC filter infections. PSAT should be considered for device-related infections in patients with cardiac assist devices[1] and artificial joints[2] when the infection flares up or recurs even after the usual 4–6 weeks of antibiotic treatment. In our case, as we obtained a negative blood culture only after 8 days (10 days from symptom onset), we considered the patient to be at high risk for relapse and initiated PSAT without confirming relapse. Further research is required to confirm the relevance of PSAT in IVC filter infection.

TABLE 1

Clinical characteristics of cases with inferior vena cava filter infection.

No.	Author/year	Age	Sex	Time of infection from IVC filter placement	Diagnosis	Causative microorganisms	IVC filter removal	Treatment duration (antibiotics)	Last outcome after treatment (follow-up duration)
1	Lin *et al.*/2000 [13]	26	F	1 week	Culture of tissue debris and clots on IVC filter	CNS	Removed	Ceftazidime (10 days)	No recurrent bacteremia (24 months)
2	Meda *et al.*/2007[11]	41	M	15 days	Culture of IVC filter	*Candida glabrata*	Removed	Amphotericin B→ capsofungin (6 weeks)	Not reported.
3	Assifi/2012[14]	34	M	5 months	Culture of IVC wall and iliopsoas abscess	MRSA	Removed	Vancomycin (6 weeks)	No recurrent bacteremia (2 months)
4	Rottenstreich/ 2015[12]	67	F	1 year	FDG-PET/CT scan	MSSA	Not retrieved (failed attempt)	Penicillin (6 weeks)	No recurrent bacteremia (42 months)
5	Rottenstreich/ 2015[12]	37	M	2 days	FDG-PET/CT scan	MRSA	Not retrieved (no attempt)	Vancomycin (6 weeks)	No recurrent bacteremia (33 months)
6	Rottenstreich/ 2015[12]	16	F	4 days	Ruled out with viral serology, CT scan, and TTE, and removal of IVC filter	Negative	Removed	Meropenem (4 weeks)	No recurrent bacteremia (27 months)
7	Our case	68	M	Many years (uncertain)	Ruled out with contrast-enhanced CT and TEE.	Extended-spectrum beta-lactamase-producing *Escherichia coli*	Not removed (no attempt)	Meropenem→ cefmetazole & amikacin→ ST as PSAT	No recurrent bacteremia (12 months)

CNS, coagulase-negative *Staphylococcus*; CT, computed tomography; F, female; IVC, inferior vena cava; M, male; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *Staphylococcus aureus*; PET, positron emission tomography; PSAT, prolonged antibiotic suppression therapy; ST, sulfamethoxazole-trimethoprim; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography.

Conclusion

Implanted devices, such as IVC filters, potentially confer a risk of secondary infection in patients with severe diseases, such as concurrent emphysematous UTIs. PSAT may be an alternative option to treat IVC filter infection, when the IVC filter is considered difficult to remove.

Ethical approval

Not required for case reports in Japan. We obtained written informed consent from the patient's family.

Patient consent

Written informed consent was obtained from the patient's family for the publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

Y.S. and A.K. equally took care of the patient, wrote and revised the draft, and approved the final version of the article.

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The authors declare that they have no conflict of interest.

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A.K. serves as the guarantor for this article.

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References

[1] Phadke VK, Pouch SM. Contemporary Management Strategies in VAD Infection. Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't Review. Curr Heart Fail Rep 2020;17:85–96.

[2] Tande AJ, Gomez-Urena EO, Berbari EF, *et al*. Management of prosthetic joint infection. Infect Dis Clin North Am 2017;31:237–52.

[3] Mobin-Uddin K, Smith P, Martinez L, *et al*. A vena caval filters for the prevention of pulmonary embolus. Surg Forum 1967;18:209–11.

[4] Sohrabi C, Mathew G, Maria N, *et al*. The SCARE 2023 guideline: updating consensus Surgical CAse REport (SCARE) guidelines. Int J Surg 2023;109:1136–40.

[5] Singer M, Deutschman CS, Seymour CW, *et al*. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016;315:801–10.

[6] Yang WH, Shen NC. Gas-forming infection of the urinary tract: an investigation of fermentation as a mechanism. Case Reports. J Urol 1990; 143:960–4.
[7] Huang JJ, Tseng CC. Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. Arch Intern Med 2000;160:797–805.
[8] Thomas AA, Lane BR, Thomas AZ, *et al*. Emphysematous cystitis: a review of 135 cases. Review. BJU Int 2007;100:17–20.
[9] Li S, Wang J, Hu J, *et al*. Emphysematous pyelonephritis and cystitis: a case report and literature review. Case Reports Review. J Int Med Res 2018;46:2954–60.
[10] Chavez-Valencia V, Orizaga-de-La-Cruz C, Aguilar-Bixano O, *et al*. Coexistence of emphysematous cystitis and bilateral emphysematous pyelonephritis: a case report and review of the literature. Case Reports Review. CEN Case Rep 2020;9:313–7.
[11] Meda MS, Lopez AJ, Guyot A. Candida inferior vena cava filter infection and septic thrombophlebitis. Case Reports Review. Br J Radiol 2007;80:e48–9.
[12] Rottenstreich A, Bar-Shalom R, Bloom AI, *et al*. Endovascular infection following inferior vena cava (IVC) filter insertion. Case Reports. J Thromb Thrombolysis 2015;40:452–7.
[13] Lin M, Soo TB, Horn LC. Successful retrieval of infected Gunther Tulip IVC filter. Case Reports. J Vasc Intervent Radiol JVIR 2000;11:1341–3.
[14] Assifi MM, Bagameri G, Dimuzio PJ, *et al*. Management of infected caval filter with simultaneous aortic pseudoaneurysm and retroperitoneal perforation: a case report and literature review. Case Reports Review. Vascular 2012;20:225–8.
[15] Jung J, Song KH, Jun KI, *et al*. Predictive scoring models for persistent gram-negative bacteremia that reduce the need for follow-up blood cultures: a retrospective observational cohort study. Observational Study. BMC Infect Dis 2020;20:680.
[16] Shi H, Kang CI, Cho SY, *et al*. Follow-up blood cultures add little value in the management of bacteremic urinary tract infections. Eur J Clin Microbiol Infect Dis 2019;38:695–702.
[17] Whitcher GH, Bertges DJ, Shukla M. Peripheral vascular stent infection: case report and review of literature. Case Reports Review. Ann Vasc Surg 2018;51:326 e9–15.
[18] Myles O, Thomas WJ, Daniels JT, *et al*. Infected endovascular stents managed with medical therapy alone. Case Reports. Catheter Cardiovasc Interv 2000;51:471–6.
[19] Morpeth S, Murdoch D, Cabell CH, *et al*. Non-HACEK gram-negative bacillus endocarditis. Multicenter Study Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't. Ann Intern Med 2007; 147:829–35.
[20] Baddour LM, Wilson WR, Bayer AS, *et al*. Infective endocarditis in adults: diagnosis, antimicrobial therapy, and management of complications: A Scientific Statement for Healthcare Professionals From the American Heart Association. Practice Guideline Review. Circulation 2015;132:1435–86.