kidney and dialysis

Case Report

Bloodstream Infection Caused by *Raoultella ornithinolytica* in a Chronic Hemodialysis Patient

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Abstract

Bloodstream infections are a significant cause of morbidity and mortality among hemodialysis patients. These infections primarily involve Gram-positive bacteria and, less frequently, Gram-negative bacilli. *Raoultella ornithinolytica* is a Gram-negative bacillus which is known to be a rare opportunistic pathogen. It is found only occasionally in human infections; however, it has been noted as an emerging pathogen. Sepsis caused by this microorganism is very rare. A few cases have been reported among immunocompromised patients or those undergoing invasive procedures. Cases involving urinary catheters or port catheters have also been reported, as well as a single case of a patient on peritoneal dialysis. Here, we present a novel case of *Raoultella ornithinolytica* bloodstream infection in a patient with chronic renal failure undergoing hemodialysis who was successfully treated. We discuss the microbiology and clinical features of such infections, and consider aspects of treatment.

Keywords: *Raoultella ornithinolytica*; enterobacteriaceae; bloodstream infection; hemodialysis; sepsis; antibiotic treatment

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1. Introduction

Bloodstream infections (BSIs) are widely recognized as an important cause of morbidity among hemodialysis (HD) patients, who are also known to face a higher risk of death from BSI than the general population [1,2]. This risk is increased by factors such as old age, underlying comorbidities, impaired immune function, and malnutrition, as well as vascular access for dialysis therapy which increases exposure to external and skin pathogens [3]. Mortality due to sepsis in this population is about 100–300 times higher than in the general population [4]. Despite the implementation of preventive measures aimed at reducing vascular-access-related infections, the incidence of BSIs remains concerningly high [5]. Gram-positive bacteria, especially *Staphylococcus aureus* and *Coagulase-negative Staphylococci* (CoNS), are traditionally the most common pathogens identified. Improved survival rates suggest that the prevalence of a large number of Gram-negative organisms is rising in BSIs [1]. Infection rates in HD patients can vary depending on various factors such as geographic location, patient population, healthcare practices, infection prevention measures, immunocompromised status, and comorbidities. HD procedures can potentially contribute to respiratory tract infections. The close proximity of patients in dialysis units results in a shared environment which may increase the risk of transmission of respiratory pathogens. *Raoultella ornithinolytica (R. ornithinolytica)*, a Gram-negative bacillus formerly classified as *Klebsiella ornithinolytica*, has gained attention in this regard. It is an encapsulated aerobic bacillus belonging to the *Enterobacteriaceae* family, commonly found in aquatic environments, soil, insects, fish, ticks, termites, and hospital settings [6,7]. Though typically overshadowed by more common pathogens, *R. ornithinolytica* has been implicated in various infections, including urinary tract infections, biliary infections, and bacteremia [8]. The accurate identification of this pathogen has been challenging due to its phenotypic similarities with *Klebsiella* species, but advances in diagnostic techniques have improved detection rates [6].

2. Case Presentation

An 80-year-old white man with chronic renal failure who had been on dialysis for 19 years was sent to the Emergency Department at the end of a dialysis session because of fever (T: 38 °C), chills, and hypotension (BP: 70/40 mmHg, HR: 70 bpm). The patient reported initial symptoms of general malaise, weakness, and dyspnea in the preceding 48 h. His medical history included being a former smoker, as well as polycystic hepatorenal disease, ischemic heart disease with dilatative-hypokinetic evolution, aortic valve disease, mitral valve disease, atrial fibrillation, and malignant otitis externa of the right ear.

Upon examination, the patient was febrile, but no signs of specific organ infection were noted. Arteriovenous fistulas had no signs of infection. Laboratory tests showed a leucocyte count in the normal range (WBC: 4560/mmc, Neutrophils: 80.1%, nv: 4000–10,000/mmc) but elevated inflammatory markers (CRP: 158.4 mg/L, nv: <5 mg/L, Procalcitonin: 4.74 μg/L, nv: <0.5 μg/L). A thoraco-abdominal CT scan with IV contrast revealed basal pleural effusion and some consolidative-atelectasis areas in the posterior segment of the left lower lobe (Figure 1). Liver and kidney cysts appeared essentially unchanged from previous examinations.

Empirical therapy with piperacillin–tazobactam was initiated with a loading dose of 9 g and a maintenance dose of 6.75 g IV over 24 h. We initiated this therapy because the patient had no specific organ signs, the first suspected site of infection could be the ear, and this therapy was effective against that bacteria. Blood cultures revealed the presence of *R. ornithinolytica*. The bacterium was not drug-resistant. Therapy was then adjusted based on susceptibility results (Supplementary Material S1), and the patient was treated with ceftriaxone 2 g IV over 24 h for 7 days. Due to a lack of severe respiratory symptoms, bronchoalveolar lavage (BAL) was not performed.

Significant clinical improvement was observed. Blood cultures taken after one week of treatment were negative, and the patient was discharged. A timeline illustrating the clinical course is provided in Table 1.

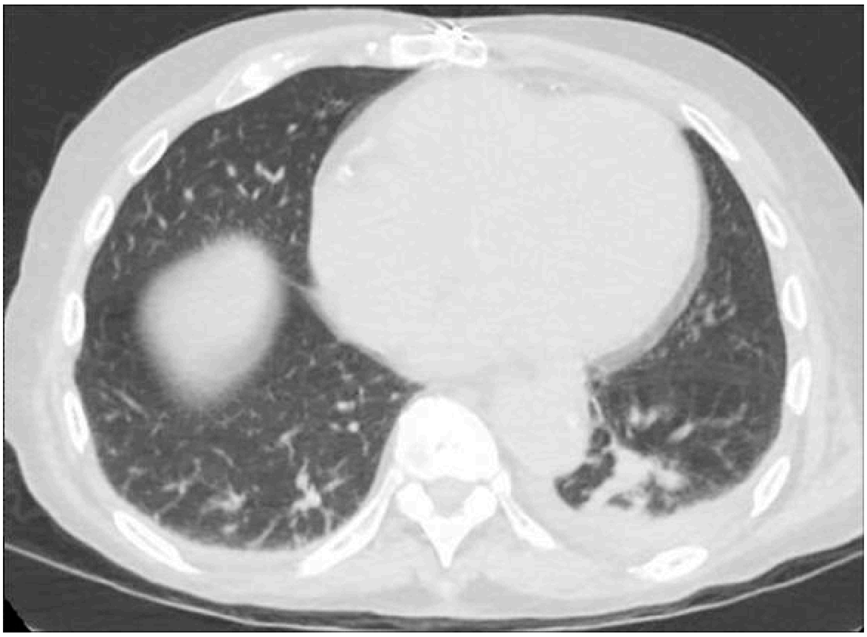

Figure 1. CT scan showing pleural effusion and some consolidative-atelectasis areas in the posterior segment of the left lower lobe, consistent with pneumonia.

Table 1. Clinical progression from symptom-onset to discharge. Empirical and targeted antibiotic treatment steps are indicated.

Timeline Day	Event	Laboratory Data	Vitals
Day 0	Onset of symptoms (malaise, weakness, and dyspnea)	Unavailable	Unavailable
Day 2	Admission to Emergency Department after dialysis session for worsening clinical condition with fever and chills Blood cultures taken	WBC: 4560/mmc CRP: 158.4 mg/L PCT: 4.74 μg/L	T: 38 °C BP: 70/40 mmHg
Day 3	Empirical antibiotic therapy with piperacillin–tazobactam initiated (loading dose of 9 g + maintenance dose of 6.75 g IV over 24 h)	WBC: 15.750/mmc CRP: 178 mg/L PCT: 8 μg/L	T: 38.5 °C BP: 80/50 mmHg
Day 4	Blood culture positive for *R. ornithinolytica;* treatment switched to ceftriaxone (2 g IV over 24 h)	WBC: 16.980/mmc CRP: 158.4 mg/L	T: 37.5 °C BP: 80/50 mmHg
Day 6–7	Improvement in clinical condition, with resolution of fever and hypotension	WBC: 10.250/mmc CRP: 28 mg/L PCT: 4.74 μg/L	T: 36.6 °C BP: 120/60 mmHg
Day 10	Normalization of infection markers Blood cultures taken	WBC: 6370/mmc CRP: 7 mg/L PCT: 1.2 μg/L	T: 36 °C BP: 120/75 mmHg
Day 12	Follow-up blood cultures negative Patient discharged	WBC: 5390/mmc CRP: 3 mg/L PCT: 0.2 μg/L	T: 36.2 °C BP: 120/75 mmHg

3. Discussion

Raoultella ornithinolytica is a Gram-negative aerobic bacterium belonging to the *Enterobacteriaceae* family that has recently emerged as an opportunistic pathogen of clinical relevance. *R. ornithinolytica* is increasingly recognized as a potential nosocomial agent due to its ability to persist in various environmental reservoirs, particularly within hospital settings [6,9]. This bacterium has been isolated from aquatic environments, soil, plants, and the human gastrointestinal tract [6,9]. Its capacity to survive on inanimate surfaces and medical devices contributes to its role in healthcare-associated infections (HAIs) [6]. In hospital environments, *R. ornithinolytica* can colonize medical equipment, including vascular and urinary catheters, facilitating transmission among vulnerable patient populations [6,9]. The organism's presence on surfaces and on biofilm formations on indwelling devices increase the risk of bloodstream infections, especially in immunocompromised hosts such as hemodialysis patients [1,3,4]. Contaminated water sources and inadequate disinfection protocols may further contribute to the persistence and spread of this bacterium in healthcare facilities [6].

From an antimicrobial standpoint, *R. ornithinolytica* is typically susceptible to cephalosporins, fluoroquinolones, carbapenems, and aminoglycosides, but shows intrinsic resistance to ampicillin due to production of chromosomal class A beta-lactamases [9]. However, an increasing number of multidrug-resistant (MDR) strains have been documented, including isolates harboring ESBLs and carbapenemase genes such as bla_KPC and bla_OXA-48 [9–11]. The emergence and dissemination of such resistant strains in hospital settings complicate infection control efforts and patient management. In the context of HD patients, multiple factors contribute to heightened infection risk, including immunosuppression from uremia, frequent healthcare contacts, the presence of vascular access devices, and comorbidities [1,3–5]. The use of catheters for vascular access provides a direct entry point for pathogens such as *R. ornithinolytica*, emphasizing the need for stringent aseptic techniques and catheter care [1].

Empirical antibiotic therapy in suspected infections should consider local antibiograms and resistance trends, especially in units with known previous colonizations or outbreaks of MDR strains. Following microbiological identification and susceptibility testing, treatment should be tailored to the specific resistance profile, to optimize outcomes and minimize further resistance development [6,9].

Prevention strategies are critical for controlling *R. ornithinolytica* infections in healthcare environments; they should include rigorous hand hygiene, environmental cleaning, strict catheter care protocols, and antimicrobial stewardship programs aimed at reducing unnecessary antibiotic exposure [3,5,6].

In this context, the use of advanced identification tools such as Matrix-assisted Laser Desorption/ionization time-of-flight Mass Spectrometry (MALDI-TOF MS) is crucial to correctly distinguish *R. ornithinolytica* from the phenotypically similar *Enterobacteriaceae* and avoid misclassification as *Klebsiella* spp. MALDI-TOF MS allows analysis of biomolecules (such as DNA and proteins) and large organic molecules (such as polymers and dendrimers), which tend to be fragile and fragmented when ionized by more conventional methods [6,9,12].

R. ornithinolytica has been linked to urinary-tract, gastrointestinal, hepatobiliary, ear, and respiratory infections [9]. In the case reported here, there were no clear organ-specific infections identified upon admission, other than slight pneumonia. However, considering the patient's medical history, several potential sites for infection and proliferation of *R. ornithinolytica* were considered. Surani et al. reported a case of an infected liver cyst in a patient with polycystic liver disease, manifesting as sepsis with a cough [13]. In our case, possible cyst infections were ruled out by CT scan. Seng et al. reported two cases of external otitis, one of which was hospital-acquired [6]. In our case, the ear was not considered a source of infection despite the patient's history of chronic recurrent otitis, sustained by the multidrug-resistant (MDR) *Klebsiella pneumoniae*. Chun et al. carried out a review of 16 cases of *R. ornithinolytica* bacteremia. Most of them (94%) involved an underlying malignant condition; the only one which did not involved a patient with end-stage renal disease who was on continuous ambulatory peritoneal dialysis (with culture from blood and dialysate fluid positive for the bacterium). Bacterial translocation from the gut was not considered a likely source of infection in this case, as the patient presented without gastrointestinal symptoms, and a contrast-enhanced thoraco-abdominal CT scan showed no signs of enteric wall alterations or intra-abdominal collections. Gut barrier dysfunction and microbial translocation are well documented in HD patients [14]. However, *R. ornithinolytica* is not typically part of the gut microbiota, and is more frequently associated with environmental or healthcare-related exposures [6,11]. In our case, additional investigations (e.g., stool cultures, fecal-calprotectin or molecular diagnostics) could have helped clarify the origin of the infection, but these were not pursued due to the patient's rapid clinical improvement and favorable therapeutic response. This is the only reported case of a chronic dialysis patient with a BSI from *R. ornithinolytica* [8].

To our knowledge, this is the first reported case of *R. ornithinolytica* infection in HD patients. HD patients often have a compromised immune system, which increases their vulnerability to infections. Several factors contribute to immunocompromised status in these patients (uremic toxins, nutritional deficiencies, vascular access, comorbidities, medications, frequent healthcare exposure, immune cell disfunction, oxidative stress, inflammation), making infections a significant concern that can lead to increased morbidity and mortality. Given all these aspects, it is not surprising to observe typically opportunist infections in this category of patients. Even though our case had a favorable clinical outcome, considering the widespread use of antibiotics in HD patients and the documented antibiotic resistance exhibited by *R. ornithinolytica*, it is crucial not to underestimate the pathogenicity of this bacterium.

4. Conclusions

Sepsis by *R. ornithinolytica* in HD patients is rare, but it can be effectively treated with timely diagnosis and appropriate antibiotic therapy. This case underscores how empirical treatment strategies in HD patients should be broad enough to cover a range of potential pathogens, including Gram-negative bacteria. The selection of antibiotics should be guided by local epidemiological data and clinical characteristics of the patients, to avoid overuse of broad-spectrum antibiotics and to minimize the risk of developing further resistance.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/kidneydial5030033/s1, S1: Antimicrobial susceptibility of *R. ornithinolytica* isolated from blood.

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Abbreviations

BAL	Bronchoalveolar lavage
blaKPC	*Klebsiella pneumoniae* carbapenemase resistant to broad-spectrum â-lactam antibiotics
BP	Blood pressure
BSI	Bloodstream infections
CoNS	Coagulase-negative staphylococci
CRBSI	Catheter-related bloodstream infections
CRP	C-reactive protein
VIM	Verona integron-encoded metallo-â-lactamase.
CT	Computer tomography
HD	Hemodialysis
HR	Heart rate
IV	Intravenous
MALDI-TOF MS	Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry
MDR	Multidrug-resistant
MIC	Minimum inhibitory concentration
nv	Normal values
OXA	Oxacillinase
T	Temperature
TMP–SMX	Trimteprim–suplhametoxazole
WBC	White blood cells
CRP	C-reactive protein
WBC	white blood cells
PCT	procalcitonin.

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