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Antimicrobial Susceptibility Patterns and Clinical Characteristics of *Corynebacterium striatum* Cases from 2018 to 2021

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Abstract

Background: Corynebacterium striatum is part of the normal flora of the skin, oral cavity, and intestine. However, it can be a pathogen causing endocarditis, pneumonia, arthritis, and meningitis occasionally. We evaluated the clinical features and antimicrobial susceptibility pattern of *C. striatum cases. Methods:* Patients infected with *C. striatum*, who consulted infectious disease physicians and were admitted to Hanyang University Hospital between January 2018 and January 2021, were enrolled for an antimicrobial susceptibility test (AST). We reviewed the medical records of selected patients for information on diagnosis, specimen types, and antibiotics used before and after AST. AST was performed using E-test and interpreted according to the Clinical and Laboratory Standards Institute M45 guidelines. *Results:* A total of 23 cases were evaluated, and the average age of patients was 58.5 years. Ten cases were diagnosed with sepsis. Eight cases were complicated with cancer, and five cases had wound infections. Four cases were treated with vancomycin prior to AST; in 13 cases, antibiotics were switched to vancomycin after AST. Resistance rates were highest for ciprofloxacin (93.3%), which was followed by cefotaxime (92.3%), penicillin G (87.0%), erythromycin (87.0%), trimethoprim/sulfamethoxazole (78.3%), and meropenem (76.5%). *Conclusion:* The patients infected by *C. striatum* were old and immunosuppressed, while many had cancer. Since *C. striatum* shows resistance to most drugs except vancomycin, we should consider conducting AST before antibiotic treatment.

Keywords

Antimicrobial susceptibility pattern
Corynebacterium striatum
Multidrug resistance

1. Introduction

Corynebacterium striatum is a gram-positive rod-shaped bacterium that is a normal colonizer of the skin, oral cavity, and intestinal tract of normal individuals and is usually considered a contaminant when identified by culture [1,2]. However, *C. striatum* can cause opportunistic infections in patients with underlying medical conditions such as diabetes, cancer, renal failure, chronic lung disease, and in patients with various indwelling catheters [3,4]. Rare cases of endocarditis, pneumonia, arthritis, and meningitis due to *C. striatum* have been reported [5-8]. Routine antimicrobial susceptibility testing of *C. striatum* isolates from patient specimens is not commonly performed in clinical laboratories and is only performed when the organism is considered to be an infectious agent. Typical *C. striatum* antimicrobial resistance positivity is susceptibility to vancomycin and resistance to beta-lactam, fluoroquinolone, and macrolides [9]. In our institution, patients with suspected *C. striatum* infections are first referred to the Department of Infectious Diseases and then to the Department of Diagnostic Tests for antimicrobial susceptibility testing. Therefore, we aimed to investigate the clinical features of patients who were referred to the laboratory for antimicrobial susceptibility testing due to suspected *C. striatum* infections during the last 3 years and to analyze the antimicrobial resistance rates of isolated strains.

2. Materials and methods

Patients who visited Hanyang University Hospital from January 2018 to January 2021 and were referred for antimicrobial susceptibility testing by an infectious disease specialist to the Department of Diagnostic Testing due to suspected infection caused by *C. striatum* were included. The diagnosis, prognosis, type of specimen, antimicrobial susceptibility test results, and antimicrobials used before and after the antimicrobial susceptibility test were compared by reviewing the medical records.

Species identification was performed using a matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) Biotyper (Bruker Daltonics, Bremen, Germany, Software version 4.2.100.19). Antimicrobial susceptibility testing was performed by the E-test (bioMérieux, Marcy l'Étoile, France) method with minor modifications referring to Clinical and Laboratory Standards Institute (CLSI) M45-ED3 guidelines [10,11]. The medium used for the antimicrobial susceptibility test (AST) was Mueller-Hinton agar, inoculated with 0.5 McFarland bacterial suspension, and incubated at 35°C for 24 hours. The antimicrobials used in the antimicrobial susceptibility test were penicillin G, cefotaxime, meropenem, vancomycin, ciprofloxacin, erythromycin, and trimethoprim-sulfamethoxazole. This study was approved by the Institutional Review Board of Hanyang University Hospital (IRB No. 202112036).

3. Results

The medical records of a total of 23 patients who visited the hospital from January 2018 to January 2021 were reviewed. The mean age was 58.5 years (2–82 years), and the gender was 11 males and 12 females (**Table 1**). Specimen types included blood, abscess, continuous peritoneal dialysis fluid, pleural fluid, cerebrospinal fluid, and tissue. Blood samples were the most common (10), and all patients with *C. striatum* isolated from blood were diagnosed with sepsis. There were five patients with wound infections and eight patients with underlying tumors. Four of the 23 patients were treated with vancomycin prior to referral for antimicrobial susceptibility testing for *C. striatum*, and the remaining 19 patients did not receive vancomycin as initial therapy. Of the 19 patients not initially treated with vancomycin, 13 changed their antimicrobial therapy to vancomycin after receiving the results of antimicrobial susceptibility testing for *C. striatum*. Patient outcomes improved in 17 patients (73.9%), and

6 patients (26.1%) died. Four of the six patients who died (cases no. 12, 15, 17, and 20) were treated with vancomycin and did not improve. They were judged to have died due to advanced age (over 65 years old), weakened immunity, severe systemic infections, and worsening of their underlying medical conditions.

The antimicrobial resistance rate for ciprofloxacin (93.3%) was the highest, followed by cefotaxime (92.3%), penicillin G (87.0%), erythromycin (87.0%), trimethoprim/sulfamethoxazole (78.3%), and meropenem (76.5%) (**Table 2**). All were susceptible to vancomycin.

Table 1. Clinical features and outcome of *C. striatum* cases between 2018 and 2021

No.	Sex/Age	Specimens	Diagnosis	Antibiotics used: AST report		Prognosis
				Before	After	
1	M/55	Blood	Peritonitis, Sepsis	Piperacillin / tazobactam	Vancomycin	Improved
2	F/74	Blood	Infective endocarditis	Ceftiaxone	Vancomycin	Improved
3	F/48	Pus	Burst fracture	Flomoxef	Vancomycin	Improved
4	M/82	CAPD fluid	Subacute ICH, aspiration pneumonia	Cefazoline	Cefazoline	Expired
5	M/74	Pus	DM foot	Ceftrazole	Vancomycin	Improved
6	M/62	Blood	AML, septic shock	Piperacillin / tazobactam	Linezolid	Expired
7	M/70	Pleural fluid	Pneumonia	Ertapenem	Vancomycin	Improved
8	M/64	Blood	Osteosarcoma, CRBSI	Cefepime	Vancomycin	Improved
9	F/72	CSF	ICH, meningitis	Ceftazidime	Vancomycin	Improved
10	M/41	Blood	Kaposi's sarcoma, CRBSI	Vancomycin	Vancomycin	Improved
11	F/2	Pus	Birth asphyxia, skin infection	Cefaclor	Cefaclor	Improved
12	F/82	Blood	UTI, CRBSI, septic shock	Vancomycin	Vancomycin	Expired
13	F/59	Tissue	Breast cancer	Ampicillin	Vancomycin	Improved
14	F/53	Wound	Diastasis recti abdominus	Piperacillin / tazobactam	Piperacillin / tazobactam	Improved
15	M/71	PICC tip	MCA infarction, sepsis	Piperacillin / tazobactam	Vancomycin	Expired
16	M/26	Wound	Skin graft on burn site	Flomoxef	Cefazoline	Improved
17	F/82	Blood	AML, sepsis	Vancomycin	Vancomycin	Expired
18	M/50	Pleural fluid	Sigmoid colon cancer, panperitonitis	Piperacillin / tazobactam	Vancomycin	Improved
19	F/52	Bone	ALS, osteomyelitis	Cefepime	Cefepime	Improved
20	F/53	Blood	Endometrial cancer, CRBSI	Piperacillin / tazobactam	Vancomycin	Expired
21	F/58	Pus	DM foot, osteomyelitis	Vancomycin	Vancomycin	Improved
22	F/61	Blood	DLBCL, CRBSI	Piperacillin / tazobactam	Vancomycin	Improved
23	M/55	Blood	AML, CRBSI	Piperacillin / tazobactam	Vancomycin	Improved

Abbreviations: M, male; F, female; AST, antimicrobial susceptibility test; CAPD, continuous ambulatory peritoneal dialysis; CSF, cerebrospinal fluid; PICC, percutaneous inserted central catheter; ICH, intracranial hemorrhage; AML, acute myeloid leukemia; CRBSI, catheter-related bloodstream infection; UTI, urinary tract infection; MCA, middle cerebral artery; ALS, amyotrophic lateral sclerosis; DLBCL, diffuse large B-cell lymphoma; DM, diabetes mellitus.

Table 2. Antimicrobial susceptibility patterns of 23 *C. striatum* isolates

Isolates	Minimum inhibitory concentration (μg/mL) and interpretation											
	Penicillin G		Cefotaxime	Meropenem		Erythromycin		Ciprofloxacin	Trimethoprim / Sulfamethoxazole		Vancomycin	
1	> 32	R	NT	> 32	R	64	R	NT	> 32	R	0.75	S
2	1	S	NT	0.47	S	> 256	R	NT	4	R	1	S
3	> 32	R	NT	> 32	R	16	R	NT	> 32	R	1	S
4	> 32	R	NT	> 32	R	6	R	NT	> 32	R	1	S
5	1.5	S	NT	0.64	S	8	R	NT	0.25	S	0.5	S

Table 2. (continued)

Isolates	Minimum inhibitory concentration (μg/mL) and interpretation															
	Penicillin G		Cefotaxime		Meropenem		Erythromycin		Ciprofloxacin		Trimethoprim / Sulfamethoxazole		Vancomycin	
6	> 32	R	NT		> 32	R	> 256	R	NT		> 32	R	1.5	S
7	> 32	R	NT		> 32	R	8	R	NT		4	R	2	S
8	> 32	R	> 32	R	NT		8	R	NT		> 32	R	2	S
9	> 32	R	> 32	R	NT		> 256	R	> 32	R	> 32	R	0.75	S
10	> 32	R	> 32	R	NT		12	R	> 32	R	> 32	R	0.75	S
11	> 32	R	> 32	R	NT		12	R	> 32	R	> 32	R	1	S
12	> 32	R	> 32	R	NT		4	R	> 32	R	2	S	0.75	S
13	> 32	R	> 32	R	NT		0.19	S	> 32	R	> 32	R	0.5	S
14	> 32	R	> 32	R	> 32	R	6	R	> 32	R	> 32	R	0.38	S
15	> 32	R	> 32	R	> 32	R	4	R	> 32	R	> 32	R	0.5	S
16	0.75	S	1	S	0.125	S	0.5	S	0.32	S	0.38	S	0.5	S
17	> 32	R	> 32	R	> 32	R	4	R	> 32	R	4	R	0.5	S
18	> 32	R	> 32	R	> 32	R	16	R	> 32	R	0.38	S	0.5	S
19	> 32	R	> 32	R	0.38	S	1	I	> 32	R	1	S	0.38	S
20	> 32	R	> 32	R	> 32	R	> 32	R	> 32	R	> 32	R	0.5	S
21	> 32	R	> 32	R	> 32	R	1.5	R	> 32	R	> 32	R	0.5	S
22	> 32	R	NT		> 32	R	16	R	> 32	R	> 32	R	0.5	S
23	> 32	R	NT		> 32	R	8	R	> 32	R	> 32	R	0.25	S
Resistance rate, % (No. of resistant isolates / No. of isolates tested)	87.0 (20/23)		92.3 (12/13)		76.5 (13/17)		87.0 (20/23)		93.3 (14/15)		78.3 (18/23)		0.0 (0/23)	

Abbreviation: S, susceptible; I, intermediate; R, resistant; NT, not tested.

4. Discussion

C. striatum is known to be multidrug resistant, and other studies have shown similar results to ours. Antimicrobial susceptibility testing was performed in 121 of a total of 179 patients with *C. striatum* infection at the University of Washington Hospital, and it was reported that 72% of the isolates were resistant to all oral antimicrobials (penicillin, ciprofloxacin, clindamycin, erythromycin, and tetracycline) [11]. In a Japanese study, 31 out of 49 (63%) *C. striatum* isolates showed high-level resistance to erythromycin, tetracycline, rifampin, and ciprofloxacin and were susceptible only to vancomycin [12]. In a review of *C. striatum* resistance by Song *et al.* [9], *C. striatum* was reported to be generally multidrug resistant but susceptible to vancomycin. We found that the *C. striatum* tested in this study also exhibited antimicrobial resistance similar to previous reports.

There are several limitations to this study. First, the E-test was not tested by liquid dilution, a standardized antimicrobial susceptibility test recommended by the CLSI. In practice, the E-test is easier to perform than the liquid dilution method for a small number of individual samples in a hospital clinical microbiology laboratory. However, there are no studies reporting the correlation between the standard method and the E-test for *C. striatum*, so the results should be interpreted with caution. Second, this was a retrospective study using medical records, and there were differences in the drugs included in the antimicrobial susceptibility test at the time of the consultation, and there were limitations in distinguishing whether the cause of death was due to underlying disease or infection from medical records.

In conclusion, this study confirmed that *C. striatum* infections occurred in cancer patients aged 65 years and older, immunocompromised, and with solid and

hematological cancers. Antimicrobial susceptibility testing is necessary because *C. striatum* has a high rate of resistance to antimicrobials other than vancomycin. Therefore, it is recommended that antimicrobial susceptibility testing should be performed when *C. striatum* infection is suspected, and appropriate therapeutic antimicrobial agents should be selected accordingly.

Disclosure statement

The authors declare no conflict of interest.

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