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***Sphingomonas paucimobilis* outbreak a pediatric haematology/oncology hospital: epidemiological investigation and literature review of an emerging healthcare-associated infection**

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Running Head: *Sphingomonas paucimobilis* outbreaks

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ABSTRACT

Sphingomonas paucimobilis is an aerobic, nonfermentative, opportunistic Gram-negative bacilli, and can be found in water systems. This study was conducted for analyzing concurrent *S. paucimobilis* bacteraemia cases and treatment outcomes, investigation of potential outbreak sources, and antimicrobial resistance profiles. This was an ambidirectional cohort study conducted in a 30-bed pediatric haematology/oncology hospital. Patient ages ranged from 1 to 17 years, with a median age of 5 years. Environmental sampling for outbreak source investigation was applied. Bacterial identification and antimicrobial susceptibility tests of isolated bacteria were done using the disk diffusion method and the Vitek®2 automated system. *S. paucimobilis* was detected in a total of 181 blood culture samples of 51 patients over two years and was isolated from hot tap water. 66% of patients were followed up with the diagnosis of Acute lymphoblastic leukemia (ALL) and two of our patients with ALL died due to *S. paucimobilis* sepsis. *S. paucimobilis* isolates were generally susceptible to carbapenems and quinolones. Surveillance and epidemic control should be done for hospital-acquired infectious agents such as *S. paucimobilis*. Water distribution systems should be checked against colonizing agents at regular intervals.

INTRODUCTION

Sphingomonas paucimobilis is an aerobic, nonfermentative, opportunistic Gram-negative bacilli, which often produces yellow pigments on blood agar (1-3). *S. paucimobilis* displays low virulence with its different glycosphingolipid structure in cell wall, lack of lipopolysaccharide components and endotoxic activity therefore infections in humans are very rare (1). Usually, it is not checked during routine hospital surveillance because it is not listed among major pathogens (3). But, especially among immunocompromised patients severe *S. paucimobilis* infections and septic shock was reported (1). This microorganism is found abundant in nature and can be found in soil and water thereby community or hospital-acquired *S. paucimobilis* infections may arise (1,4). The source of nosocomial infections of *S. paucimobilis* may be endogenous (previous colonization of the patient), environmental (various medical devices), or contamination of sterile fluids in hospitals (5). The source of the infection may also be biofilm formation in the water distribution systems of the hospitals (6). Biofilm formation of *S. paucimobilis* in water pipes was defined in industrial ultra pure water systems, spacecraft, and hospital water distribution systems (3). To date, there are no definitive guidelines for antimicrobial therapy for *S. paucimobilis* infections (7). Strains of *S. paucimobilis* are generally resistant to penicillins and first-generation cephalosporins due to the production of chromosomally encoded beta-lactamases (8).

This study was conducted after the detection of *S. paucimobilis* bacteraemia in a pediatric haematology-oncology ward of a university hospital. Suspicion of an outbreak of infection potentially associated with bacteria derived from environmental reservoirs prompted a study of the microbiological quality of the hospital water supply in particular. Antimicrobial susceptibilities, treatment regimens, and clinical outcomes were also evaluated to discuss the clinical characteristics of pediatric patients, outbreak containment measures, and possible new treatment options.

MATERIALS AND METHODS

The Gaziantep University Oncology Hospital is a tertiary medical center with a 23-bed pediatric haematology-oncology service and a seven-bed bone marrow transplantation unit. In our study, the blood culture results of the patients hospitalized in the pediatric haematology-oncology service and bone marrow transplantation unit were evaluated. Information such as age, gender, and underlying disease of the patients was recorded. The study included patients with clinical symptoms of bacteraemia such as fever and/or tachycardia, as well as *S. paucimobilis* isolated from sterile blood samples. Patients were classified as true positives if no bacteria were isolated in clinical samples in a site other than the blood or other than *S. paucimobilis* that would explain the current symptoms. If there was evidence of direct contact with patients with *S. paucimobilis* bacteraemia, environmental samples were classified as true positives.

Clinical data and bacterial culture results were used to pinpoint the source of bacteraemia. Primary bacteraemia was defined as bacteraemia without an infectious focus. Positive simultaneous blood cultures from the central venous catheter and peripheral vein yielding the same organism in the presence of at least one of the following were defined as catheter-related bloodstream infection. 1) Simultaneous quantitative blood cultures in which the quantity of CFU/mL isolated from blood collected through a central catheter is 5 times that of blood drawn peripherally. 2) Positive catheter tip cultures, either semi-quantitative (15 CFU/catheter segment) or quantitative (100 CFU/catheter segment). 3) Simultaneous blood cultures of equal volume, with the central blood culture growing 2 hours before the peripheral blood culture in an automated system (9).

Blood culture samples were included in the study for a two-year period between January 2019 and December 2020. In compliance with sterility rules, two sets of blood cultures were taken from distinct peripheral veins when the patient had a fever or when infection was suspected clinically. In addition, blood samples from central venous catheter patients were taken at the same time the catheters were implanted to eliminate any concerns regarding the catheter's sterility. Blood culture samples were evaluated in the Bactec Fx (BD, USA) blood culture system. Samples that gave positive signals during the seven-day incubation period were inoculated on Columbia agar with 5% sheep blood (BD, USA) and eosin methylene blue agar (EMB; BD, USA). The inoculated plates were incubated at 37°C for 48 hours.

During outbreak source investigation, a total of 123 samples were collected from 28 different areas; primarily hot tap water, cold tap water, storage water, infusion pump, kitchen treatment water, distilled water used in treatment, medicine preparation bench, endoscopy devices. Shower water samples were collected in sterile containers before and after the showerhead was removed and after being flowed for 30 seconds after removal to detect potential biofilm formation. Environmental samples were inoculated onto Columbia agar with 5% sheep blood (BD, USA) and EMB agar (BD, USA) and incubated at 37°C for 48 hours. Water samples were also inoculated onto pediatric blood culture bottles (BD, USA) to increase the detection chance that may be reduced by the lower bacterial load.

S. paucimobilis isolates were identified as Gram-negative rods with yellow pigmentation, no glucose fermentation, and a weak oxidase activity. The *S. paucimobilis* isolates were identified according to biochemical profiles established with the use of Vitek 2 compact system GN ID card (bioMérieux, France). Each isolate was further tested for antibiotic susceptibility using the Vitek 2 (bioMérieux, France) system (AST-326 antimicrobial susceptibility testing card for

nonfermentative Gram-negative bacteria) according to the manufacturer's instructions and the Clinical and Laboratory Standards Institute's (CLSI) standards (10). In addition, Kirby-Bauer method was used for cefoperazone-sulbactam sensitivity, which is not included in the automated system. Because there were no established breakpoints for cefoperazone-sulbactam, zone diameters were evaluated using cefoperazone breakpoints for the Enterobacterales (10). As part of infection control measures; the infection control committee of the hospital, physicians, nursing staff, and patients who had *Sphingomonas* bacteraemia were informed about the general characteristics of bacteria and potential sources. Institutional education on health-care-associated infections was initiated. A routine water disinfection program was discussed with technical service personnel boiling tank water and chlorination were applied. Also according to the institutional decision, the hospital contracted with a private firm for tank water disinfection with 6 months period. For general evaluation of cleaning, adenosine triphosphate (ATP) hygiene monitoring tests were used and results were delivered to supervisor nurses. A general disinfection program was applied throughout the wards.

The Pubmed and Google Scholar databases were used to conduct the literature search. '*Sphingomonas paucimobilis* bacteraemia' and '*Sphingomonas paucimobilis* epidemic' were used. Articles that may have been overlooked were checked in the reference sections of the reviewed articles. The study was approved by Gaziantep University Ethics Committee for Clinical Trials and was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

S. paucimobilis was detected in a total of 181 blood culture samples of 51 patients over two years in 2019 and 2020. Patients' ages were varying between 15 months and 17 years, and the median age of the patients was five years. 34 (66%) of patients were followed up with the diagnosis of Acute lymphoblastic leukemia (ALL) and other patients were followed up with diagnoses such as solid tumors (13%), Hodgkin and non-Hodgkin lymphomas (6%), combined immunodeficiency (4%) and other haemato-oncology diseases (10%). *S. paucimobilis* growth was detected in a total of 19 blood culture samples in 2019 and in a total of 162 in 2020, and in four different hot tap waters, which were considered as a source of infection. The water sources from which *S. paucimobilis* water samples were taken were often used for personal cleansing of the patients and their companions every other day. Furthermore, it was discovered that several patients used the same water source as drinking water when questioned. When analyzing the case distribution from 2019 to 2020 (Figure 1), it was discovered that it peaked in July of 2020. Samples were collected from 123 different locations in August 2020 to discover the source of the infection, and *S. paucimobilis* was isolated from four separate hot water sources that could have been a cause of infection. In August 2020, infection control procedures were also resumed, and the number of cases gradually declined over the next few months but did not entirely eradicate. There was a remarkable increase in cases between July and October months when the average temperature was higher (Figure 1). While *S. paucimobilis* was isolated only in the period between July and November in 2019, there was an increase in cases seen throughout the year in the period between July and October in 2020 (121 of 162 samples, 74%).

Based on clinical and microbiological evidence, 17 patients were diagnosed with catheter-related bloodstream infections, and 34 patients were diagnosed with primary bacteraemia. The catheters

of the patients who were thought to have a catheter-related infection were removed. A deterioration of the clinical state necessitated intensive care in 10 of the patients who were followed up. In five of these patients, mechanical ventilation was required. *S. paucimobilis* sepsis resulted in the deaths of two of our ALL patients. The clinical characteristics of the patients are detailed in Table 1.

According to antimicrobial susceptibility test results obtained by Vitek 2 (bioMérieux, France), *S. paucimobilis* isolates were generally susceptible to carbapenems and quinolones. Detailed results of antimicrobials were shown in Figure 2. Also upon clinical request, determined by the disc diffusion method, all isolates were susceptible to cefoperazone-sulbactam. All patients were given cefoperazone-sulbactam as an empirical therapy, considering their immune status. Eight patients did not respond to cefoperazone-sulbactam treatment after one week, and their fevers and blood cultures remained positive. The antibiogram was assessed in individuals who did not respond to treatment, and meropenem treatment was commenced.

DISCUSSION

Hospital-acquired infections cause significant problems due to higher morbidity, mortality, and increased institutional and financial burden compared to community-acquired infections (5). Because of the intensive treatments and severe and extended immunosuppression, haemato/oncology units have the greatest rate of nosocomial infection (11). In particular, Gram-negative nonfermenter bacteria can affect the hospital environment and/or equipment, the hands of healthcare workers, and prolonged stay in the hospital. It is a common cause of hospital-acquired infections due to its tendency to colonize inpatients and these bacteria can present a

complex antimicrobial resistance profile, often associated with a variety of resistance mechanisms (3).

S. paucimobilis is also found in nature, soil, water, and outdoors, and rarely causes hospital infections (4,12,13). Although the pathogenicity of the bacteria is weak, it can cause infections that result in 5.5% mortality, especially when it is stated that patients receive immunosuppressive therapy and have a haematological history (4,14). In our study, this rate was found to be 3.9% over a two-year period. Although we encountered *S. paucimobilis* only in blood samples for two years, *S. paucimobilis* has been isolated from different samples such as blood, urine, sputum, CSF, and synovial fluid and has been shown to cause infection (8,15).

All of the patients included in our study were pediatric haematology-oncology patients. However, *S. paucimobilis* generally has been associated with different comorbidities such as malignancy, diabetes mellitus, alcoholism, liver cirrhosis, end-stage renal disease, chronic obstructive pulmonary disease, burns, AIDS (8).

The susceptibility of *S. paucimobilis* isolates to third-generation cephalosporins and fluoroquinolones may vary. In the study of Cheong et al. (16), *S. paucimobilis* isolates show antibiotic resistance to cefotaxime and amikacin. In the study of Özdemir et al. (17), the microorganism was found to be sensitive to cephalosporins, aminoglycosides, quinolones, and trimethoprim/sulfamethoxazole, except for cefoxitin and ceftazidime. Two decades ago, it was recommended by Hsueh et al. (14) to start aminoglycoside and a third-generation cephalosporin together as an appropriate antibiotic for the treatment of *S. paucimobilis* infections. But today this antibiotherapy regime may be inadequate for the treatment of *S. paucimobilis* infections when we look at the antibiotic susceptibility of the isolates obtained in our study (Figure 2). All of our

isolates were found to be susceptible to imipenem. Again, the sensitivity rate to meropenem was 91%. Levofloxacin and ciprofloxacin sensitivities were also found to be high (92.9% and 93.2%, respectively). However, contrary to the literature, susceptibility to aminoglycosides was not as high as expected and it was observed that there was a higher resistance to aminoglycosides compared to other antibiotics. Due to the limited use of the quinolone group in pediatric patients, carbapenems were preferred for the treatment of patients. However, interestingly, carbapenems that were found to be susceptible in-vitro were reported as unsuccessful in treatment by the attending clinicians. We did not find similar data supporting this finding but it may be out of the sight of clinicians in sporadic cases due to low virulence of *S. paucimobilis* or may be related to heteroresistance. Cefoperazone-sulbactam susceptibility, which was not included in the automated system panel, was tested with the disc diffusion method as an alternative treatment with a beta-lactamase inhibitor, and all isolates were found susceptible. Again, when we followed the blood cultures of the patients and the attending clinicians were consulted, it was reported that the success of cefoperazone-sulbactam in the treatment of *S. paucimobilis* bacteraemia was high.

S. paucimobilis was isolated from the hot tap water in 3 different patient rooms and from the one hot tap water in the bone marrow transplantation unit, but the bacteria could not be isolated from the tank waters. This situation brought to mind the possibility of biofilm formation in the plumbing pipes (6). *Sphingomonas* can form a dense biofilm on colonized surfaces and can accumulate very strong and sticky exopolymers (5). We also experienced that it is easier to isolate water samples in blood culture bottles, which we attributed to the low bacterial density. However, the cost-effectiveness and standardization of this method are open to future discussion. In addition, it is estimated that approximately 95% of bacteria in drinking water distribution systems are attached to the surface of the inner pipe walls, with only 5% in the water phase and

detected in samples taken for quality control (18). According to the WHO drinking water standard, achieving satisfactory disinfection and 2–3 mg/L of chlorine should be added to the water to maintain the remaining concentration (19). *Sphingomonas* was found to be resistant to chlorine at a concentration of 2 mg/L (6). Studies suggest that higher concentrations of chlorine (8mg/L) should be used to prevent biofilm development and that lower chlorine concentrations are not effective in biofilm formation (6). In Turkey, according to the relevant regulation, it was determined as 'If chlorine is used in the disinfection of drinking water, free chlorine level is ensured to be 0.2-0.5 mg/L in the measurements to be made at the extreme point.' These limits allow biofilm formation for *Sphingomonas*. The hospital water system has been identified as a source of infection in earlier studies, including one in a neutropenic patient and another in a pediatric haematology-oncology clinic. (11, 20) Direct and indirect contact, swallowing and aspiration of contaminated water, or inhalation of aerosols can all lead to pathogen contamination from the water reservoir (21). This demonstrates why, particularly in immunosuppressive patients, tap water should not be used for cleansing or drinking. All these reasons show that *Sphingomonas* can cause water-borne infections and more sensitive behavior is required to ensure microorganism detection. After *S. paucimobilis* was discovered in water sources in our source investigation, the tank water was boiled and chlorinated as part of infection prevention measures. The use of tap water as a source of drinking water was restricted for the patients. Following the implementation of the measures, the number of instances reduced dramatically (Figure 1). Further sample were collected from water sources, but no bacterial growth was discovered in the following period. Despite this, *S. paucimobilis* infections still occur on a rare basis, though not in epidemic form.

Another striking aspect of our study is that the cases show a significant increase in the hot summer months. The highest positive rate of *Sphingomonas* blood culture results of the patients was seen between July and October. While *S. paucimobilis* was isolated only in the period between July and November in 2019, there was an increase in cases seen throughout the year in the period between July and October in 2020. (121 of 162 samples were 74%). Furthermore, we could only isolate *S. paucimobilis* from hot tap water. This may be indicative for understanding the bacterial physiology of *S. paucimobilis*.

When the literature was reviewed, our study, which covered a period of 2 years, included the one of the highest number of *S. paucimobilis* infection cases. When we investigated 28 different reports (1,2,4,5,8,11,12,15,17,20,22-39) from various geographical locations it was seen that a total of 178 patients infected with *S. paucimobilis* were followed up mostly due to primary bacteraemia (49%). In our study, 34 patients out of 51 patients were followed up with primary bacteraemia (66%). Endocarditis, osteomyelitis, and infections associated with the central nervous system were observed less frequently. In total, 7 patients (4%) died due to *S. paucimobilis* infection according to previous reports. The mortality rate associated with *S. paucimobilis* was 3.9 % in our study, which was similar to previous studies. Previous reports showed that *S. paucimobilis* can cause infections in both immunocompromised and previously healthy individuals (22,25,28,32). However, all but one of the patients who died due to *S. paucimobilis* infections were reported to have a comorbid disease that would affect the immune system (1,2,4,36,32). This indicates that, in terms of preventing mortality in immunocompromised individuals, more attention should be devoted to the contamination of water resources and the usage of tap water. Remarkably, 82 (46%) of 178 patients reported in previous studies were from Turkey (2,11,17,24,25,27,33,36). It's also worth noting that the

majority of the cases were reported from Asian countries (4,26,28,31,32,35,37). When our study is included, 205 (89.5%) of 229 patients in total were reported from Turkey (62.4%) and Taiwan (27.1%). Some countries, such as Turkey and Taiwan, should be particularly cautious when it comes to *S. paucimobilis* because of the high temperatures throughout the summer months. Table 2 shows detailed demographic information about the patients, as well as the infection's focus (1,2,4,5,8,11,12,15,17,20,22-39).

Increasing clinical evidence indicates that water is a source of nosocomial infection (20). To reduce the risk of water-borne infections in tertiary hospitals, rational limits for acceptable quality of hospital water need to be defined, as well as the development of reasonable and robust sanitation procedures.

As a limitation of our study genetic analysis of the strains was not performed in order to prove that the same clone infected all patients. But we acknowledge that *S. paucimobilis* outbreaks are a very challenging chronic problem for us and it is fair to expect some genetic alterations. We still continue to encounter cases in 2021, albeit in small numbers, due to reasons such as the colonization of bacteria in the hospital water distribution system by forming a biofilm, the chlorine level in the water not being at a level to prevent this, and the patient population being immunosuppressed due to underlying diseases. This paper may also be accepted as a call for solution proposals.

As a result, surveillance and epidemic control should be done for hospital-acquired infectious agents such as *S. paucimobilis*, which can cause serious infections in immunosuppressed patients, although its pathogenicity is less than other Gram-negative bacteria, and water distribution systems should be checked against colonizing agents at regular intervals.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1. Quarterly distribution of *S. paucimobilis* cases seen between 2019-2020 along with isolation from environmental samples

Figure 2. Antimicrobial susceptibility results of *S. paucimobilis* isolates

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Table 1. Demographic and clinical characteristics of patients infected with *S.*

paucimobilis

Case	Age (Years)	Focus of Infection	ICU / MV	Cefoperazone -sulbactam treatment	Underlying disease	Clinical Outcome
1	5	CRBSI	-/-	Responsive	ALL	Recovery
2	3	CRBSI	-/-	Responsive	ALL	Recovery
3	2	Primary bacteremia	-/-	Responsive	Wilms' tumor	Recovery
4	9	CRBSI	+/+	Unresponsive	ALL	Death
5	2	CRBSI	-/-	Responsive	Neuroblastoma	Recovery
6	2	CRBSI	-/-	Responsive	ALL	Recovery
7	13	CRBSI	-/-	Responsive	AML	Recovery
8	4	Primary bacteremia	-/-	Responsive	ALL	Recovery
9	4	CRBSI	-/-	Unresponsive	ALL	Recovery
10	11	CRBSI	+/-	Responsive	ALL	Recovery
11	10	Primary bacteremia	-/-	Responsive	ALL	Recovery
12	7	Primary bacteremia	-/-	Responsive	NHL	Recovery
13	12	Primary bacteremia	+/+	Unresponsive	ALL	Death
14	3	Primary bacteremia	-/-	Responsive	ALL	Recovery
15	12	Primary bacteremia	-/-	Responsive	AML	Recovery
16	6	Primary bacteremia	-/-	Unresponsive	ALL	Recovery
17	4	Primary bacteremia	-/-	Responsive	ALL	Recovery
18	5	Primary bacteremia	-/-	Responsive	ALL	Recovery
19	1	Primary bacteremia	-/-	Responsive	ALL	Recovery
20	3	Primary bacteremia	-/-	Responsive	Fibrosarcoma	Recovery
21	3	CRBSI	-/-	Responsive	ALL	Recovery
22	4	CRBSI	-/-	Responsive	Medulloblastoma	Recovery
23	4	Primary bacteremia	-/-	Unresponsive	ALL	Recovery
24	8	Primary bacteremia	-/-	Responsive	NHL	Recovery
25	4	Primary bacteremia	-/-	Responsive	Embryonal carcinoma	Recovery
26	8	Primary bacteremia	-/-	Responsive	ALL	Recovery
27	4	CRBSI	+/+	Responsive	Rhabdomyosarcoma	Recovery
28	7	Primary bacteremia	-/-	Responsive	ALL	Recovery
29	5	Primary bacteremia	-/-	Responsive	ALL	Recovery
30	9	Primary bacteremia	-/-	Responsive	AML	Recovery
31	1	CRBSI	-/-	Responsive	Neuroblastoma	Recovery
32	3	CRBSI	+/+	Unresponsive	Combined Immunodeficiency	Recovery
33	14	Primary bacteremia	-/-	Unresponsive	NHL	Recovery
34	4	Primary bacteremia	-/-	Responsive	ALL	Recovery
35	2	Primary bacteremia	+/+	Responsive	Combined Immunodeficiency	Recovery
36	17	Primary bacteremia	-/-	Responsive	ALL	Recovery
37	1	CRBSI	+/-	Responsive	ALL	Recovery
38	1	CRBSI	-/-	Responsive	ALL	Recovery
39	5	Primary bacteremia	-/-	Unresponsive	ALL	Recovery
40	14	Primary bacteremia	-/-	Responsive	AML	Recovery

Table 1. Demographic and clinical characteristics of patients infected with *S. paucimobilis*

41	13	Primary bacteremia	-/-	Responsive	ALL	Recovery
42	11	Primary bacteremia	-/-	Responsive	ALL	Recovery
43	14	Primary bacteremia	+/-	Responsive	ALL	Recovery
44	14	Primary bacteremia	-/-	Responsive	ALL	Recovery
45	6	CRBSI	+/-	Responsive	ALL	Recovery
46	7	Primary bacteremia	-/-	Responsive	ALL	Recovery
47	5	Primary bacteremia	-/-	Responsive	ALL	Recovery
48	5	Primary bacteremia	-/-	Responsive	Neck tumor	Recovery
49	4	Primary bacteremia	-/-	Responsive	ALL	Recovery
50	7	CRBSI	+/-	Responsive	ALL	Recovery
51	5	Primary bacteremia	-/-	Responsive	ALL	Recovery

ICU: need for intensive care unit, MV: need for mechanical ventilation, CRBSI: Catheter Related Bloodstream Infection, ALL:Acute Lymphoblastic Leukemia AML:Acute Myeloid Leukemia NHL:Non Hndgkin Lymphoma

Table 1. Demographic and clinical characteristics of patients infected with *S. paucimobilis*

Table 2. Clinical characteristics and manifestations of patients with *Sphingomonas paucimobilis* infection from the literature review

Author	Number of Cases	Mean of Age	Focus of Infection	Clinical Outcome	Reported Comorbidities	Country/ Year
Rognrud et al ²²	1	47 years	Endocarditis	Recovery	Previously healthy	USA / 2020
Bavaro et al ⁵	3	69 years	CRBSI	Recovery	End stage renal disease	Italy / 2020
Osuji et al ²³	1	12 hours	Primary bacteremia	Recovery	Newborn	Nigeria / 2020
Gursoy et al ²⁴	1	50 years	CRBSI	Recovery	End stage renal disease	Turkey / 2018
Goker et al ²⁵	1	48 years	CNS	Recovery	Previously healthy	Turkey / 2017
Lugito et al ¹	1	55 years	Primary bacteremia	Death	DM, colonic tbc, end stage renal disease	Indonesia / 2016
Chowdhary et al ²⁶	1	1 day	Primary bacteremia	Recovery	Newborn	India / 2016
Demiray et al ²⁷	33	61 years	Primary bacteremia (n:16), Pneumonia (n:7), STI (n:6), UTI (n:4)	Recovery	Malignancy, DM, coronary artery disease, chronic renal insufficiency, cerebrovasculer disease	Turkey / 2016
Saboor et al ²⁸	1	10 years	Primary bacteremia	Recovery	Previously healthy	Pakistan / 2016
Al-Halawani et al ²⁹	1	31 years	STI	Recovery	HIV and HCV coinfection	USA / 2015
Sirmatel et al ²	5	59 years	Primary bacteremia(n:2), STI (n:1), Peritonitis (n:1), Vaginal cuff infection (n:1)	1 patient death	Chronic renal failure, Malignancy	Turkey / 2015
Benevides et al ³⁰	1	11 years	Otomastoiditis	Recovery	Chronic bilateral otitis media	Brazil / 2014
Moushmi et al ³¹	1	7 years	Primary bacteremia	Recovery	Epilepsy	India / 2014
Pascale et al ⁸	1	26 years	Osteomyelitis	Recovery	Previously healthy*	Italy / 2013
Tai et al ³²	1	31 years	CNS	Death	Previously healthy	Malaysia / 2013

Table 2. Clinical characteristics and manifestations of patients with *Sphingomonas paucimobilis* infection from the literature review

Bayram et al ³³	24	4 years	Primary (n:20), bacteremia , CRBSI (n:2), UTI (n:1),CNS (n:1)	Recovery	ALL, burn injury, prematurity, Down Syndrome	Turkey / 2013
Souto et al ³⁴	1	41 years	Septic arthritis	Recovery	Hyperuricemia,gout	Spain / 2012
Ozdemir et al ¹⁷	1	1 years	Primary bacteremia	Recovery	Down syndrome	Turkey / 2011
Lin et al ³⁵	16	54 years	Primary bacteremia (n:5), CRBSI (n:3), STI (n:3), Pneumonia (n:3), UTI (n:1), Biliary tract infection (n:1)	Recovery	Malignancy, Steroid use, DM	Taiwan / 2010
Mutlu et al ³⁶	13	33.7 weeks	Primary bacteremia	1 patient Death	Preterm labor, Prolonged ruptured of membrans, newborn	Turkey/ 2010
Toh et al ⁴	55	50 years	Primary bacteremia (n:15), Pneumonia (n:12), Head and neck infection (n:12), STI (n:10), CRBSI (n:2), UTI (n:2), CNS (n:2)	3 patients death	DM, Alcoholism, Malignancy, Steroid use	Taiwan / 2010
Maragakis et al ¹²	6	53 years	Primary bacteremia	Recovery	Subarachnoid hemorrhage, Head and neck tumor	USA / 2009
Kuo et al ³⁷	1	47 years	Septic arthritis	Recovery	DM	Taiwan / 2009
Seo et al ³⁸	1	62 years	Postoperative endophthalmitis	Recovery	Previously healthy	Korea / 2008
Kilic et al ¹¹	4	8 years	Primary bacteremia	Recovery	AML , NHL, Neuroblastoma	Turkey / 2007

Table 2. Clinical characteristics and manifestations of patients with *Sphingomonas paucimobilis* infection from the literature review

Al-Anazi et al ³⁹	1	14 years	Primary bacteremia	Recovery	AML	Saudi Arabia / 2005
Charity et al ¹⁵	1	16 years	STI	Recovery	ALL	UK / 2004
Perola et al ²⁰	1	57 years	CRBSI	Recovery	ALL, neutropenia	Finland / 2002

CRBSI: Catheter Related Bloodstream Infection, CNS: Central Nervous System, DM: Diabetes Mellitus, Tbc: Tuberculosis, UTI: Urinary Tract Infection, STI: Soft Tissue Infection
 AML: Acute Myeloid Leukemia, ALL: Acute Lymphoblastic Leukemia, NHL: Non-Hodgkin Lymphoma

* The patient recently underwent surgery from the area where the infection developed.

Table 2. Clinical characteristics and manifestations of patients with *Sphingomonas paucimobilis* infection from the literature review

Figure 1. Quarterly distribution of *S. paucimobilis* cases seen between 2019-2020 along with isolation from environmental samples

Figure 2. Antimicrobial susceptibility results of *S. paucimobilis* isolates (n: 181)