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ORIGINAL ARTICLE

Stenotrophomonas maltophilia bacteremia and pneumonia at a tertiary-care oncology center: a review of 16 years

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Abstract

Purpose The aim of this study was to describe the clinical characteristics and antimicrobial patterns of *Stenotrophomonas maltophilia* bloodstream infections (BSI) and pneumonia episodes in patients with cancer.

Methods Patients with *S. maltophilia* BSI or pneumonia admitted from 1 Jan. 2000 to 31 Dec. 2016 were identified at the Instituto Nacional de Cancerología (INCan), a tertiary-care oncology hospital in Mexico City.

Results During the study period, there were 171 isolates identified. The mean age of the whole group was 46.9 ± 17.4 years; 99 (57.9%) were women. There were 95 BSI: 64 ambulatory catheter-related BSI (CRBSI), 20 nosocomial CRBSI, and 11 secondary BSI. Mortality was higher in nosocomial CRBSI (40%) vs. that in ambulatory CRBSI (7.8%) ($p = 0.001$). There were 76 pneumonia episodes; all were nosocomial acquired; 46 (60.5%) ventilator-associated. From all the group, nine strains (5.2%) were resistant to sulfamethoxazole/trimethoprim/(SMX/TMP). At the first month, 54 patients (31.6%) have died, 38 due to pneumonia (70%) and 16 due to BSI (30%, $p < 0.001$). Multivariate analysis showed that removal of central venous catheter was associated with a favorable outcome in patients with bacteremia. For patients with pneumonia, age ≥ 65 years and inappropriate antimicrobial treatment were risk factors associated with 30-day mortality.

Conclusions *S. maltophilia* related with ambulatory CRBSI have a better prognosis than other sources of BSI. Older patients with pneumonia who do not receive appropriate antibiotics have higher mortality. SMX/TMP is still the antibiotic of choice.

Keywords *Stenotrophomonas maltophilia* · Bloodstream infection · Pneumonia · Mortality · Bacterial resistance

Introduction

Stenotrophomonas maltophilia is an ubiquitous aerobic, non-fermentative, Gram-negative bacillus, first identified in 1961 [1]. It exists in humid environments, water sources, soil, and plants; it is not considered part of normal human microbial flora [2]. In the last decades, it has emerged as a pathogen due to its ability of biofilm formation and site adhesion, which makes it easy to be a transient colonizer of hospitalized patients, mainly in the respiratory and gastrointestinal tracts [3, 4]; an increasing number of studies report *S. maltophilia* as a nosocomial pathogen, causing infections with considerable morbidity in immunocompromised patients [1, 3, 4]. Risk factors among patients infected or colonized with *S. maltophilia* are malignancy, chronic respiratory diseases, prolonged hospital stay, admission to the intensive care unit (ICU), previous antibiotic treatment, and the use of indwelling devices [4]. Infections with *S. maltophilia* are usually bacteremia and/or pneumonia, although other infections, such as endocarditis, osteomyelitis and joint, urinary tract, and soft-tissue infections, have also been described [1].

S. maltophilia is intrinsically resistant to several antibiotics commonly used to treat nosocomial infections; thus, a delay is frequent in the administration of appropriate antibiotics [1]. Even worse, in recent years, there have been reports on increasing resistance to sulfamethoxazole/trimethoprim (SMX/TMP), the current drug of choice for treatment [3].

The aim of this study was to describe the microbiological and clinical characteristics of *S. maltophilia* bloodstream infections (BSI) and pneumonia episodes in patients with cancer

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and to identify prognostic factors associated with mortality in these patients.

Methods

All the blood and sputum records of the Mexico City-based Instituto Nacional de Cancerología (INCan) Microbiology Laboratory from 1 Jan. 2000 to 31 Dec. 2016 were reviewed, and all medical records of *S. maltophilia*-positive isolates were included. The study was approved by the Institutional Review Board (INCAN/Rev/10/17).

INCan is a 135-bed referral teaching hospital for adult patients with cancer, with an average of 170,000 medical visits, 35,000 chemotherapy sections, and 7500 hospital discharges per year. The intravenous therapy team takes care of 900 central venous catheters (CVC) monthly, mostly outpatients and long-term indwelling CVC.

Data on demographic and clinical characteristics, such as underlying malignancies, comorbidities, date of admission and discharge, antimicrobial therapy, ICU admission, date of positive cultures, site of isolation (blood, sputum, bronchial aspirate, and/or pleural fluid), type of antimicrobials and number of days used, and infection outcomes at 30 days were retrieved from the patients' medical records, including microbiological data such as co-isolated organisms and susceptibility results for levofloxacin (LVX), ceftazidime (CAZ), and SMX/TMP. Respiratory samples were cultured on four plates: MacConkey, Sheep Blood, Sabouraud, and Chocolate agars. Blood samples and pleural fluid were processed by the automated blood culture BACTEC 9240 System (Becton-Dickinson Microbiology Systems, USA). Identification and susceptibility were identified by Phoenix BD™.

Definitions

- BSI: The isolation of bacteria from one or more peripheral venous blood samples collected from a patient associated with symptoms and signs relevant to systemic infection, such as fever, chills, and hypotension.
  - (a) Catheter-related BSI (CRBSI): Patient with an intravascular catheter and two of the following criteria: blood culture obtained from the CVC lumen compared to that obtained from peripheral puncture with time to positivity of > 2 h; or isolation of the same organism from blood cultures and from semi-quantitative culture segment [5, 6].
  - (b) Nosocomial CRBSI: Infection acquired > 48 h after hospitalization and not present or incubating on admission.
  - (c) Secondary BSI: Isolation of the same microorganism identified in an infection site in another part of the body.
- Recent antimicrobials, recent chemotherapy, and previous hospitalization: Within the previous 3 months.
- Severe neutropenia: Neutrophils count < 500 cells/mm^3.
- Pneumonia: Radiological criteria on chest x-ray or a computed tomography (CT) scan plus one or more of the following: fever (≥ 38 °C) or hypothermia (< 35 °C); new cough with or without sputum production, pleurisy chest

Table 1 Demographic and clinical characteristics in patients with *S. maltophilia* bloodstream infection (BSI) and pneumonia infection

Characteristics—*N* (%)	BSI (*n* = 95)	Pneumonia (*n* = 76)	*p*	Total (*n* = 171)
Age (years)[a]	42.5 ± 16.1	52.4 ± 17.4	< 0.001	46.9 ± 17.4
Feminine gender	64 (67.4)	35 (46.1)	0.005	99 (57.9)
Hematologic neoplasm	32 (33.7)	31 (40.8)	0.338	63 (36.8)
Solid tumor	63 (66.3)	45 (59.2)		108 (63.1)
Oncologic status[b]			< 0.001	
Recent diagnosis	32 (33.7)	43 (56.7)		75 (43.8)
Progression	46 (48.4)	12 (15.8)		58 (33.9)
Relapse	8 (8.4)	9 (11.8)		17 (9.9)
Complete remission	0	9 (11.8)		9 (5.3)
Partial remission	9 (9.5)	3 (3.9)		12 (7)
Chemotherapy[c]	62 (65.3)	28 (36.8)	< 0.001	90 (52.6)
Severe neutropenia[d]	17 (17.9)	14 (18.4)	0.929	31 (18.1)
Body mass index (kg/m^2)[a,e]	26.8 ± 7.7	24.1 ± 4.3	0.01	25.7 ± 6.6

[a] Mean ± standard deviation (SD)

[b] Analysis was performed comparing recent diagnosis, complete and partial remission vs. progression, and relapse

[c] Chemotherapy within 3 months

[d] Neutrophils < 500 cells/mm^3

[e] Body mass index was calculated weight/height^2

pain, dyspnea, and altered breathing sounds on auscultation.
- Ventilator-associated pneumonia (VAP): Pneumonia that occurred 48–72 h or thereafter following endotracheal intubation.
- Appropriate antimicrobial treatment: Useful antibiotic for *S. maltophilia* initiated within the first 48 h of the initial infection's symptoms for at least 72 h.

The cancer stage was classified as recently diagnosed, relapse, progression, complete remission, and partial remission.

Overall case mortality rate was defined as death by any cause within 30 days of infection onset.

Statistical analysis

Quantitative variables were calculated as median and interquartile range (IQR). Categorical data were analyzed using the chi-square or the Fisher exact test, as appropriate. For the analysis, pneumonia events were divided into two groups: VAP and non-VAP. BSI episodes were divided into three groups: ambulatory CRBSI, nosocomial CRBSI, and secondary BSI. Comparison was made with ANOVA, Wilcoxon rank sum test, or chi-square for continuous or categorical data as correspond. Logistic regression models were employed to examine the effects of multiple risk factors on mortality in pneumonia and in BSI. Variables included in the model were those that reached a significance level of $p \leq 0.1$ in the univariate analysis. Data was analyzed using STATA (ver. 14; Stata Corp., College Station, TX, USA) statistical software.

Results

During the study period, 44,979 blood cultures were taken. Of these, 7666 (17%) were positive, 5176 (67.5%) were Gram-negative bacilli (GNB), and 95 *S. maltophilia* episodes were identified, 1.8% of all GNB and 1.2% of all blood isolates.

Table 2 Clinical characteristics in patients who developed bloodstream infection (BSI) classified in ambulatory catheter-related BSI (CRBSI), nosocomial CRBSI, and secondary BSI

Characteristics—*N* (%)	CRBSI ambulatory (*n* = 64)	CRBSI nosocomial (*n* = 20)	*p*[a]	Secondary BSI (*n* = 11)	*p*[b]	Total (*n* = 95)
Age (years)[c]	43.1 ± 15.9	41 ± 17.6	0.603	41.7 ± 15.9	0.866	42.5 ± 16.1
Feminine gender	43 (67.2)	14 (70)	1	7 (63.6)	0.745	64 (67.4)
Hematologic cancer	15 (23.4)	13 (65)	0.0006	4 (36.4)	0.006	32 (33.7)
Solid tumor	49 (76.6)	7 (35)		7 (63.6)		63 (66.3)
Oncologic status[d]			0.610		0.752	
Recent diagnosis	18 (28.1)	10 (50)		4 (36.4)		32 (33.7)
Progression	33 (51.6)	7 (35)		6 (54.5)		46 (48.4)
Relapse	4 (6.2)	3 (15)		1 (9.1)		8 (8.4)
Complete remission	0	0		0		0
Partial remission	9 (14.1)	0		0		9 (9.5)
Previous hospitalization[e]	33 (51.6)	11 (55)	0.804	4 (36.4)	0.355	48 (50.5)
Recent antimicrobials[e]	15 (23.4)	13 (65)	0.001	3 (27.3)	1	31 (32.6)
Recent chemotherapy[e]	44 (68.8)	15 (75)	0.780	3 (27.3)	0.01	62 (65.3)
Recent surgery[f]	10 (15.6)	3 (15)	1	1 (9.1)	1	14 (14.7)
Hospitalization[e]	26 (40.6)	20 (100)	n/a	11 (100)	0.02	57 (60)
Catheter removal	58 (90.6)	14 (70)	0.03	2 (18.1%)	n/a	74 (77.8)
Polymicrobial	12 (18.8)	5 (25)	0.537	2 (18.1)	1	19 (20)
Received appropriate antimicrobial treatment[g]	45 (70.3)	13 (65)	0.782	6 (54.5)	0.330	64 (67.4)
Death at 30 days	5 (7.8)	8 (40)	0.001	3 (27.3)	0.388	16 (16.8)

[a] *p* value was obtained comparing ambulatory vs. nosocomial-CRBSI

[b] *p* value was obtained comparing all CRBSI group vs. secondary BSI

[c] Mean ± standard deviation (SD)

[d] Analysis was made comparing recent diagnosis, partial and complete remission vs. progression, or relapse

[e] During the previous 3 months

[f] Surgery during the previous 6 months

[g] Useful antimicrobials initiated during the first 48 h of the initial infection's symptoms and received for at least 72 h

During the same period, 10,982 cultures from pleural fluid, sputum, or bronchial aspirate were taken: 2762 with bacteria isolated (25.1%) and 1911 GNB (69.2%) identified; 76 *S. maltophilia*, corresponding to 3.9% of all GNB and 2.7% of all lung cultures.

The study included 171 episodes of *S. maltophilia* infection: 95 BSI (55.6%) and 76 pneumonias (44.4%). The infections occurred sporadically, no outbreak was identified during the 16 years of data, and there was not a relation with a specific month. The mean age of the whole group was 46.9 ± 17.4 years; 99 patients (57.6%) were women. Solid tumors were diagnosed in 108 (63.2%) and hematologic malignancies in 63 (36.8%). Other clinical characteristics are presented in Table 1.

On analyzing the 95 BSI episodes, we found 84 CRBSI: 64 (67.4%) were in ambulatory patients with long-term indwelling CVC and 20 (21%) were nosocomial. Nosocomial CRBSI was more frequent in patients with hematologic malignancies, while ambulatory CRBSI was more frequent in solid tumors ($p = 0.0006$). Nosocomial CRBSI was associated with the use of antimicrobials within 3 months when compared with ambulatory CRBSI ($p = 0.001$). Seventy-two catheters were removed (85.7%): 58 (90.6%) in ambulatory CRBSI and 14 (70%) in nosocomial CRBSI ($p = 0.03$) (Table 2).

Eleven patients (11.6%) had secondary BSI (two patients with severe neutropenia, two with urinary tract infections, one cholangitis, one phlebitis, one cellulitis, one abdominal source, and in three cases, the source was unknown).

Nineteen patients (20%) had polymicrobial bacteremia without differences when comparison was made between nosocomial vs. ambulatory CRBSI, neither when all the CRBSI were compared with secondary BSI. There were six patients with SMX/TMP resistance: five received ciprofloxacin and CVC was removed. They were alive in the first month; the other patient died in the first 24 h since blood cultures were taken. Three strains were resistant to CAZ; one of these was also resistant to LVX.

From the whole BSI group, 16 patients died at the first month (16.8%). Mortality was higher in patients with nosocomial CRBSI ($n = 8$, 40%), compared with that of ambulatory

Table 3 Uni- and multivariate analysis of factors associated with 30-day mortality cancer patients with *Stenotrophomonas maltophilia* pneumonia or bloodstream infection

Bloodstream infections—30-day mortality						
Characteristic—*N* (%)	Alive ($n = 79$, 83.2%)	Death ($n = 16$, 16.8%)	Univariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Age < 65 years	72 (91.1)	14 (87.5)	1.46 (0.13–8.85)	0.644	–	–
Age ≥ 65 years	7 (8.9)	2 (12.5)				
Solid tumor	54 (68.4)	9 (56.2)	1.68 (0.47–5.71)	0.391	–	–
Hematological	25 (31.6)	7 (43.7)				
No received chemotherapy	27 (34.2)	6 (37.5)	0.86 (0.25–3.22)	0.781	–	–
Received chemotherapy	52 (65.8)	10 (62.5)				
Received SMX/TMP[a]	38 (48.1)	11 (68.8)	0.42 (0.1–1.48)	0.173	–	–
No received SMX/TMP	41 (51.9)	5 (31.2)				
Appropriate treatment[b]	55 (69.6)	9 (56.2)	1.78 (0.49–6.07)	0.381	–	–
Inappropriate treatment	24 (30.4)	7 (43.7)				
CVC removed[c]	71 (98.6)	6 (60)	0.02 (0.0004–0.3)	< 0.001	0.03 (0.003–0.32)	0.003
CVC did not remove	1 (1.4)	4 (40)				
Pneumonia—30-day mortality						
Characteristic—*N* (%)	Alive ($n = 38$, 50%)	Death ($n = 38$, 50%)	Univariate		Multivariate	
			OR (95% CI)	*p*	OR (95% CI)	*p*
Age < 65 years	34 (84.5)	25 (65.7)	4.4 (1.15–20.5)	0.02	1.00	0.03
Age ≥ 65 years	4 (10.5)	13 (34.2)			4.17 (1.14–15.21)	
Solid tumor	18 (47.3)	17 (44.7)	0.89 (0.33–2.43)	0.818	–	–
Hematological	20 (52.6)	21 (55.3)				
No received chemotherapy	22 (57.9)	26 (68.4)	0.63 (0.22–1.74)	0.341	–	–
Received chemotherapy	16 (42.1)	12 (31.6)				
Received SMX/TMP	15 (39.5)	23 (60.5)	OR 0.42 (0.15–1.17)	0.06	1.00	0.810
No received SMX/TMP	23 (60.5)	15 (39.5)	3.37 (1.18–9.8)		0.87 (0.3–2.65)	
Appropriate treatment	27 (71.1)	16 (42.1)		0.01	1.00	0.04
Inappropriate treatment	11 (28.9)	22 (57.9)			3.08 (1.01–9.4)	

[a] Sulfamethoxazole/trimethoprim (SMX/TMP)

[b] Appropriate antimicrobial treatment was defined as useful antibiotic for *S. maltophilia* initiated within the first 48 h of the initial infection's symptoms for at least 72 h

[c] Percentage was obtained from 84 patients who were diagnosed with CLABSI

CRBSI (7.8%, $p = 0.001$). No differences were found when all CRBSI groups were compared with secondary BSI (27.3%, $p = 0.388$). (Table 2). Considering only patients with CVC, mortality was increased in those who did not remove it (58.3%, 7/12 patients), vs. those whose CVC was removed (8.3%, 6/72 patients) ($p = 0.002$).

In univariate and multivariate analysis, removal of CVC was associated with a favorable outcome (OR 0.03, CI 95% 0.003–0.32, $p = 0.003$). Risk factors explored for mortality (age ≥ 65 years, hematologic vs. solid tumor, recent use of chemotherapy, appropriate antimicrobial treatment, and the use of SMX/TMP) were not associated with higher mortality (Table 3).

Analyzing the 76 pneumonia episodes, all were nosocomial. Thirty patients (39.5%) were classified as non-VAP and 46 (60.5%) as VAP. Female patients had more VAP episodes compared with male (58.9 vs. 26.7%, $p = 0.005$). Patients with solid tumors had more VAP episodes compared with those of hematological malignancies (60.6 vs. 30.4%, respectively, $p = 0.02$). Previous hospitalization and chemotherapy in the previous 3 months were more frequent in non-VAP vs. VAP ($p < 0.001$) (Table 4).

There were no differences in susceptibility for SMX/TMP, LVX, or CAZ between VAP and non-VAP. There were three patients with SMX/TMP resistance; all died in less than 3 days. The three strains were also resistant to CAZ; none was resistant to LVX.

Table 4 Clinical characteristics in patients who developed pneumonia classified as ventilator-associated pneumonia (VAP) and non-VAP

Characteristics—*N* (%)	Non-VAP ($n = 30$)	VAP ($n = 46$)	*p*	Total ($n = 76$)
Age (years)[a]	49.7 ± 18.9	54.1 ± 16.3	0.290	52.4 ± 17.4
Feminine gender	8 (26.7)	27 (58.9)	0.005	35 (46.1)
Hematologic neoplasm	17 (56.7)	14 (30.4)	0.02	31 (40.8)
Solid tumor	13 (43.4)	32 (69.6)		45 (59.2)
Oncologic status[b]			0.616	
Recent diagnosis	17 (56.6)	26 (56.5)		43 (56.7)
Progression	8 (26.7)	4 (8.7)		12 (15.8)
Relapse	2 (6.7)	7 (15.2)		9 (11.8)
Complete remission	1 (3.3)	8 (17.4)		9 (11.8)
Partial remission	2 (6.7)	1 (2.2)		3 (3.9)
Previous hospitalization[b]	18 (60)	10 (21.7)	< 0.001	28 (36.8)
Days of previous hospitalization[c]	9 (4, 10)	7 (5, 9)	0.772	8 (4, 10)
Recent antimicrobials[b]	4 (13.3)	3 (6.5)	0.424	7 (9.2)
Recent chemotherapy[b]	18 (60)	10 (21.7)	< 0.001	28 (36.8)
Recent surgery[d]	6 (20)	22 (28.9)	0.01	28 (26.8)
Hospitalization	30 (100)	46 (100)	1	76 (100)
Length of hospitalization (days)[c]	22 (11, 40)	29 (17, 43)	0.175	25 (15, 42)
ICU stay	9 (30)	42 (91.3)	< 0.001	51 (67.1)
Length of ICU stay (days)[c]	10 (5, 15)	15 (8, 20)	0.340	14 (8, 20)
SOFA[a]	6 ± 2.1	7.5 ± 3.6	0.214	7.3 ± 3.4
APACHE II[a]	13.2 ± 3.3	16.3 ± 7.8	0.255	15.8 ± 7.3
Severe neutropenia[e]	7 (23.3)	7 (15.2)	0.383	14 (18.4)
Polymicrobial	4 (13.3)	4 (8.7)	0.704	8 (10.5)
Received appropriate antimicrobial treatment[f]	19 (63.3)	24 (52.2)	0.337	43 (56.5)
Death at 30 days	13 (43.3)	25 (54.3)	0.347	38 (50)

ICU intensive care unit, *SOFA* sequential organ failure assessment, calculated only in patients admitted to the ICU, *APACHE*-II Acute Physiology and Chronic Health Evaluation, calculated only in patients admitted to the ICU

[a] Mean ± standard deviation (SD)

[b] During the previous 3 months

[c] Median (interquartile range)

[d] Surgery during the last 6 months

[e] Less than 500 neutrophils/mm^3

[f] Useful antimicrobials initiated during the first 48 h of the initial infection's symptoms and received for at least 72 h

Thirty-eight patients (50%) died in the first 30 days after *S. maltophilia* isolation; no differences were observed between VAP and non-VAP ($p = 0.347$). In multivariate analysis, independent factors associated with death were ≥ 65 years old (OR 4.17, CI 95% 1.14–15.21, $p = 0.03$) and not receiving an appropriate antimicrobial treatment (OR 3.08, CI 95% 1.01–9.4, $p = 0.04$). (Table 3).

Discussion

This study represents, represents until now, the largest series of cancer patients with bacteremia or pneumonia secondary to *S. maltophilia*. It highlights that this is an important pathogen with high mortality.

Analyzing BSI, episodes of CRBSI were the most frequent (88.4%) as have been reported by several investigators [1]. This can be explained because *S. maltophilia* adheres to abiotic surfaces such as CVC [7], despite the use of maximal barrier precautions during catheter insertion and other antiseptic techniques in view of the widespread use of CVC in cancer therapy. However, this infection is low at our institution, taking into account that the number of catheters that are placed and care for is approximately 1000 per year and the number of patients with permanent catheters cared for by the intravenous therapy team is around 600 per month. We have reported a CRBSI rate of 0.66 per 1000/catheter-days over the past 15 years [8]. In the current study, 84.5% of patients with CRBSI had a good prognosis; this was related with early catheter removal in combination with appropriate antimicrobial therapy, as has been reported previously [7, 9].

The number of cases with polymicrobial bacteremia was less than that of other series (20 vs. 38%) [1], but we did not find differences in mortality when compared with monomicrobial BSI. The variety of bacteria that we recovered in polymicrobial blood cultures reflects the different pathways through which *S. maltophilia* can enter the bloodstream (water source via contact, during showering in patients in whom CVC protection can be disrupted, inhalation, ingestion, or aspiration) [1, 10].

Many different types of antibiotic agents (SMX/TMP, fluoroquinolones, aminoglycosides, and extended-spectrum penicillins/cephalosporins) have demonstrated in vitro activity against *S. maltophilia* infections [11, 12]. The percentage of susceptibility found in the strains isolated in this study (SMX/TMP 95%, LVX 80%, and CAZ 31%) (Fig. 1) were practically the same as those reported in other studies: SMX/TMP ranged from 94 to 96%; fluoroquinolones, 76 to 82%; and CAZ, 22 to 37% [11, 13]. Thus, we can consider that SMX/TMP is, in our setting, an optimal option for the treatment of this pathogen, considering LVX for resistant cases. CAZ has only showed activity in vitro, and its clinical utility is limited. In this series, six patients received ciprofloxacin instead of LVX, mainly due to the availability and the low cost of the ciprofloxacin in our hospital. Regardless of the previous, rates of susceptibilities in vitro comparing activities of LVX and ciprofloxacin against clinical bacterial isolates have been reported to be 85.5 and 58.9%, respectively, being LVX a much better option. More than 95% of the *S. maltophilia* strains have been reported susceptible to newer fluoroquinolones [14].

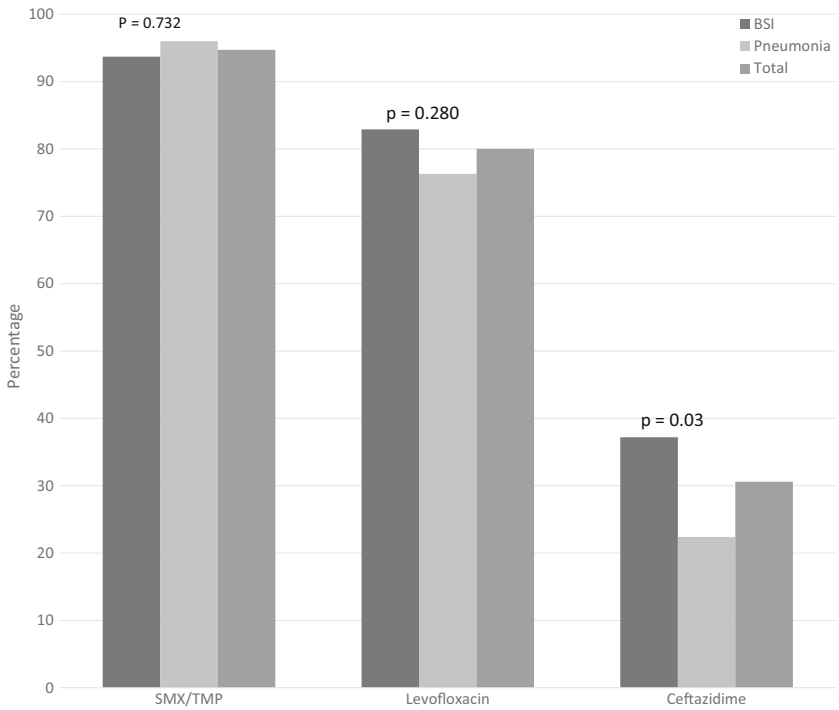

Fig. 1 Susceptibility of *Stenotrophomonas maltophilia* strains from patients with BSI and pneumonia

The increasing resistance to specific antibiotic agents, as well as the high rates of resistance to currently used antimicrobial agents hampers the treatment of *S. maltophilia*-associated infections [4]. Extensively drug-resistant (XDR) isolates have been described recently [15]. We found only one patient with an XDR strain, a 62-year-old male patient with ambulatory CRBSI and *S. maltophilia* strain resistant to LVX, CAZ, and SMX/TMP, who had been hospitalized during the previous 3 months at our hospital (not in the ICU). The CVC was removed, and the infection was resolved.

We describe a whole mortality rate of 32.8%, similar than that of other reports, which report mortality in a range from 22 to 62%. As *S. maltophilia* infection occurs mainly in patients with comorbidities, in these complex patients with cancer, the mortality observed cannot be exclusively attributed to it [4]. Inappropriate therapy and older age were significant risk factors for death in patients with pneumonia. Other studies have described hematological disease and admission to the ICU as poor prognostic factors in *S. maltophilia* pneumonia [1, 11].

In patients with bacteremia, poor prognosis included shock and thrombocytopenia [16] and we found as a protector factor for mortality the CVC removal.

This study has some limitations: we included patients from a single tertiary-care referral cancer center, which may make difficult to apply our results to other hospitals. We conducted a retrospective study; thus, it may have selection and information biases; and, the mortality-related cause could be unmasked by underlying neoplastic diseases and other medical conditions. On the other hand, the study strengths include that we were able to identify colonization and infection, and only the latter were included. Also, this is, to our knowledge, one of the largest series reported in patients with cancer.

Conclusions

S. maltophilia infections represent a significant problem in cancer patients, mainly attributable to the difficulty in treating these infections, because this pathogen presents intrinsic resistance to various antibiotic agents. The elevated mortality in patients with pneumonia was related to older age and inappropriate antimicrobial treatment during the first 48 h of the diagnosis of infection. SMX/TMP is still the antibiotic of choice in our setting.

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Compliance with ethical standards The study was approved by the Institutional Review Board (INCAN/Rev/10/17).

Conflict of interest The authors declare that they have no conflict of interest.

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