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Microbiological profile of isolated microorganisms from patients in intensive care units of a Hospital in Lambayeque, Peru, 2019-2020

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MICROBIOLOGICAL PROFILE OF ISOLATED MICROORGANISMS FROM PATIENTS IN INTENSIVE CARE UNITS OF A HOSPITAL IN LAMBAYEQUE, PERU, 2019-2020

PERFIL MICROBIOLÓGICO DE MICROORGANISMOS AISLADOS DE PACIENTES EN UNIDADES DE CUIDADOS INTENSIVOS DE UN HOSPITAL DE LAMBAYEQUE, PERÚ, 2019-2020

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ABSTRACT

Objective: To describe the microbiological profile of microorganisms isolated from patients in critical care units of a hospital in the Lambayeque region in 2019-2020. **Methods:** Descriptive, retrospective, cross-sectional study with a quantitative approach. A census study was carried out on 332 patients from critical care units (CCUS) with a positive microbiological culture registered in the file of the microbiology laboratory of the Lambayeque Regional Hospital in 2019-2020. The statistical software Info stat v8 was used for statistical analysis. **Results:** The median age was 50 years, predominantly male (55,1%). The most frequent culture sample was bronchial secretion (35,8%). The most frequently isolated microorganisms were A. baumannii complex (27,7%) resistant to meropenem and imipenem with 90,7% and 89,3% respectively, P. aeruginosa (13,9%) resistant to cefepime with 55,8% and 61,1% for Piperacillin / tazobactam, E. coli (11,1%) resistant to ampicillin with 94,7%; and K. pneumoniae (9,9%) resistant to ampicillin / sulbactam by 79,2%. **Conclusion:** The most frequent microorganisms isolated from the study population were the A. baumannii complex, P. aeruginosa, E. coli and K. pneumoniae; isolated mainly from respiratory secretions, of which the first two showed high resistance to carbapenems and aminoglycosides, and in the next two, half were ESBL.

Keywords: Intensive care units, Drug resistance; Anti-Infective agents; Microbiology; Hospitals. (Source: MeSH NLM).

RESUMEN

Objetivo: Describir el perfil microbiológico de los microorganismos aislados de pacientes de las unidades de cuidados críticos de un hospital de la región Lambayeque en el 2019 – 2020. **Métodos:** Estudio descriptivo, retrospectivo, transversal y de enfoque cuantitativo. Se realizó un estudio censal a 332 pacientes de las unidades de cuidados críticos (UCCs) con cultivo microbiológico positivo registrado en el archivo del laboratorio de microbiología del Hospital Regional Lambayeque en el 2019 - 2020. Se utilizó el software estadístico Info stat v8 para el análisis estadístico. **Resultados:** La mediana de edad fue de 50 años a predominio de sexo masculino (55,1%). La muestra de cultivo más frecuente fue la secreción bronquial (35,8%). Los microorganismos que se aislaron con mayor frecuencia fueron A. baumannii complex (27,7%) resistente a meropenem e imipenem con 90,7% y 89,3% respectivamente, P. aeruginosa (13,9%) resistente a cefepime con 55,8% y 61,1% para Piperacilina / tazobactam, E. coli (11,1%) resistente a ampicilina con 94,7%; y K. pneumoniae (9,9%) resistente a ampicilina/sulbactam en un 79,2%. Conclusión: Los microorganismos más frecuentes aislados de la población de estudio, fueron A. baumannii complex, P. aeruginosa, E. coli y K. pneumoniae; aislados mayoritariamente de secreciones respiratorias, de los cuales, los dos primeros presentaron alta resistencia a carbapenémicos y aminoglucósidos, y en los dos siguientes, la mitad fueron BLEE.

Palabras claves: Unidad de Cuidados Intensivos; Farmacorresistencia microbiana; Antibacterianos; Microbiología; Hospitales. (Fuente: DeCs BIREME).

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INTRODUCTION

Antimicrobial resistance, a process between microorganisms and antimicrobials where the drug loses efficacy, becoming a complex challenge for public health, this natural phenomenon is currently accelerated by the misuse of antimicrobials [1,2].

Currently, it is common to identify microbiological isolates in the hospital environment and outside of it, with resistance levels ranging from multidrug-resistant (MDR), extremely resistant (XDR), and even pan-resistant, in which no type of antimicrobial has an effect. With respect to the latest estimates for the Prevention and Control of Diseases of the United States (CDC), these microorganisms have a high economic impact of 35 million additional dollars in medical expenses; in turn, they are the cause of more than 2 million infections and 23,000 deaths annually in the US[3].

In the CCUs, there is a diversity of microorganisms that are exposed to different antiseptic agents, which causes them to generate a specific resistance for each antimicrobial group. In these units, patients are found in a vulnerable state due to their homeostatic and immunological instability, which makes them more easily infected by these microorganisms [4].

Antimicrobial resistance is understood as the mechanisms that can produce various types of microorganisms in response to the use of drugs that are used for the treatment and prophylaxis of diseases caused by these. This is increased with its indiscriminate use by the population [5].

There are two types of resistance, intrinsic, specific properties of bacteria, whose same species are invariably resistant to some groups of antibiotics. On the other hand, the acquired type is revealed in therapeutic failures in patients infected with these bacterial strains that, through certain mechanisms, become resistant to the drug that was usually sensitive [6].

Worldwide, as in India, it was shown that the most frequent species isolated in critical care units were Staphylococcus aureus and Klebsiella pneumoniae, both resistant to cephalosporins. In addition, more than half of the S. aureus found were S. aureus resistant to methicillin (MRSA), and none of them were resistant to linezolid and vancomycin [7].

A study, conducted at the Latin American level, reported that the most frequently isolated bacteria in critical care units were Escherichia coli and K. pneumoniae resistant to ampicillin, cefazolin, and piperacillin/tazobactam [8].

In 2014, in a social security hospital in Chiclayo, it was shown that the most frequently isolated bacteria in the Intensive Care Unit (ICU) were K. pneumoniae, 27.3%; Pseudomonas aeruginosa, 13.6% and E. coli, 11.5% resistant to cephalosporins and sensitive to carbapenems and aminoglycosides [9].

The objective of this study was to describe the microbiological profile of the microorganisms isolated from patients in the critical care units of a hospital in the Lambayeque region in 2019-2020. This research allowed us to have quality control for treating infections that occur, unlike other hospitals in the region.

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METHODS

Design and study area

A descriptive, retrospective, cross-sectional study with a quantitative approach was carried out in the CCUs of the Lambayeque Regional Hospital (HRL).

Population and sample

The study population was patients from the HRL CCUs with positive microbiological culture, treated from April 2019 to March 2020. The study was census.

The unit of analysis was the microbiological cultures registered in the HRL microbiology laboratory during the study period. Patients from critical care units with positive microbiological culture recorded in the HRL microbiology laboratory file were included. Incomplete or illegible records from the HRL microbiology laboratory file were excluded.

Variables and instruments

The microbiological profile is a document that includes frequency and resistance data corresponding to microorganisms isolated from patients cared for in a certain place, space, and time, to which statistical interpretation is added[10].

The samples were processed by the VITEK® system in the study, automated bacterial identification, and antimicrobial susceptibility study system. The identification of bacteria is based on the inoculation of a suspension of microorganisms on cards with certain panels of biochemical reactions. Antimicrobial susceptibility is carried out similarly through cards containing standardized dilutions of different antibiotics corresponding to the susceptibility cutoff points established as of 2018[11].

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Epidemiological variables were also studied: age and gender; laboratory variables: service of origin and type of sample; microbiological variables: isolated microorganism and antimicrobial susceptibility (sensitive, intermediate, and resistant).

Procedures

The record of results of positive microbiological isolates of patients admitted to critical care units between April 2019 and March 2020 was reviewed.

Statistical analysis

In a database created in the Microsoft Excel 2019 program, it was The information obtained from the laboratory record was processed and subsequently sent to the statistical software Info stat v8, for its corresponding analysis. Descriptive statistics were performed, calculating absolute and relative frequencies for the categorical variables; and measures of central tendency and dispersion for the quantitative variables, taking into account their normal distribution according to the Kolmogorov-Smirnov goodness-of-fit test.

Ethical aspects

The study in question was reviewed by the San Martin de Porres University (Official Letter No. 23 - 2021 - CIEI-FMH-USMP) and HRL (Inv_Code: 0211-086-19 CEI) for its approval. The confidentiality of the results obtained from the patients under study was always maintained, assigning codes to their names and surnames for their identification. Likewise, the custody of said information will be in charge exclusively of the researchers; the corresponding permits were requested from the hospital to carry out the research. The risks of participating in the study were minimal.

RESULTS

The study included 332 microbiological records of patients treated in critical care units of the HRL, during 2019 and 2020. The study population was characterized by a median age of 50 years, with an interquartile range (IQR) of 28 to 66. Likewise, the median age in the Pediatric Special Care Unit (PCU) and ICU was one year (IQR= 1 - 8) and 51 years (IQR= 36 - 70), respectively.

Table 1 shows the demographic characteristics of the study population, where there is a predominance of the male sex (55.1%) and the age group of 18 to 59 years (57.2%).

Table 1. Demographic characteristics of patients treated in the critical care units of the Lambayeque Regional Hospital, 2019-2020 (N= 332)

Demographic characteristics	N	%
Sex		
Female	149	44.9
Male	183	55.1
Age (years)		
0 to 17	34	10.2
18 to 59	190	57.2
60 to more	108	32.5

While in Table 2, the laboratory characteristics of the study population, the most frequently obtained samples with positive culture were from the respiratory tract (TR= Bronchial secretion, Tracheal aspirate, Bronchoalveolar lavage) 57.8%; for urine culture, it was 22.9%, and the service of origin was ICU 91.3%.

Table 2. Laboratory characteristics of patients with culture positive microbiological from the critical care units of the Lambayeque Regional Hospital, year 2019-2020 (N = 332)

Laboratory characteristics	N	%
Type of sample		
Bronchial secretion	119	35.8
Urine culture	76	22.9
Tracheal	50	15.1
Blood culture	26	7.1
Catheter tip	25	7.5
Bronchoalveolar lavage	23	6.9
Wound secretion	4	1.2
Cerebrospinal fluid	2	0.6
Tissue	3	0.9
Others	4	1.2
Department of origin		
PCU	29	8.7
ICU	303	91.3

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And Table 3 shows the microbiological characteristics of the study population; approximately 50.0% of the E. coli and K. pneumoniae regardless of the sample's origin, were extended-spectrum beta-lactamases (ESBL). Gram-negative bacteria represented 70.7% of the microbial isolates.

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Table 3. Microbiological characteristics of microbial isolates from patients from the critical care units of the Lambayeque Regional Hospital , year 2019-2020

Microbiological characteristics	N	%
Microbial type (N=332)		
Bacteria	287	86.4
Fungus	45	13.6
ESBL producers (N=36)		
E. coli	18	50.0
K. pneumoniae	18	50.0
Isolated microorganism (N=332)		
A. baumannii complex	92	27.7
P. aeruginosa	46	13.9
E. coli	37	11.1
K. pneumoniae	33	9,9
Candida albicans	26	7.8
S. haemolyticus	19	5.7
S. epidermidis	15	4.5
C. tropicalis	13	3.9
S. aureus	11	3.3
Stenotrophomonas maltophila	8	2.4
Proteus mirabilis	7	2.1
P. mallei	5	1.5
C. glabrata	4	1.2
Enterococcus faecalis	3	0.9
C. krusei	2	0.6
Enterobacter cloacae	2	0.6
Serratia marcescens	2	0.6
S. hominis	2	0.6
Enterobacter aerogenes	1	0.3
Moraxella spp	1	0.3
Morganella morganii	1	0.3
S. mitis	1	0.3
S. saprophyticus	1	0.3

Finally, Table 4 shows the E. coli with a high sensitivity profile to carbapenems such as meropenem, followed by ertapenem; and finally amikacin.

Sensitivity for the cephalosporin group was low; for urine samples, ceftriaxone obtained 5% while nitrofurantoin retains its high antimicrobial response. Amikacin and meropenem maintain their response to K. pneumoniae; For the TR samples, cefepime had a low response together with ciprofloxacin.

Resistance was maintained for trimethoprim/sulfamethoxazole in E. coli and for the first (cefazolin) and third (ceftriaxone and ceftazidime) generation cephalosporins; the highest percentages of K. pneumoniae were for ampicillin/sulbactam and ceftazidime.

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Table 4. Sensitivity profile of E. coli and K. pneumoniae of the microbial isolates of patients from the critical care units of the Lambayeque Regional Hospital, year 2019-2020, according to sample type

Micro organism	Sample	N (%)	Antibiotics													
			Ampicilina-sulbactam (%)	Amikacina (%)	Cefepime (%)	Ceftriaxona (%)	Ceftazidima (%)	Cefazolina (%)	Ciprofloxacina (%)	Ertapenem (%)	Gentamicina (%)	Imipenem (%)	Meropenem (%)	Nitrofurantoina (%)	Piperacilina / tazobactam (%)	Trimetoprim/sulfametoxazol (%)
	Urine	21 (56.8)	3/14 (21,4)	20/21 (95,2)	2/19 (10,5)	1/20 (5,0)	2/18 (11,1)	2/13 (15,4)	5/19 (26,3)	16/17 (94,1)	6/20 (30,0)	19/20 (95,0)	3/3 (100,0)	18/20 (90,0)	12/14 (85,7)	4/17 (23,5)
E. coli	RT	10 (27,0)	1/5 (20,0)	9/9 (100,0)	1/8 (12,5)	1/8 (12,5)	0/1 (0,0)	0/4 (0,0)	3/10 (30,0)	7/7 (100,0)	3/9 (33,3)	10/10 (100,0)	10/10 (100,0)	1/1 (100,0)	SD	2/9 (22,2)
	Others	6 (16,2)	2/4 (50,0)	3/3 (100,0)	2/4 (50,0)	2/5 (40,0)	0/1 (0,0)	0/1 (0,0)	2/4 (50,0)	3/3 (100,0)	5/5 (100,0)	5/5 (100,0)	5/5 (100,0)	SD	1/1 (100,0)	0/3 (0,0)
K. pneumoniae	**All**	37 (100,0)	6/23 (26,1)	32/33 (97,0)	5/31 (16,1)	4/33 (12,1)	2/20 (10,0)	2/18 (11,1)	10/33 (30,3)	26/27 (96,3)	14/34 (41,2)	34/35 (97,1)	18/18 (100,0)	19/21 (90,5)	13/15 (86,7)	6/29 (20,7)
	Urine	10 (30,3)	1/8 (12,5)	8/10 (80,0)	1/10 (10,0)	1/8 (12,5)	1/9 (11,1)	0/3 (0,0)	1/10 (10,0)	SD	SD	SD	1/2 (50,0)	0/8 (0,0)	5/8 (62,5)	1/8 (12,5)
	RT	18 (54,6)	2/13 (15,4)	17/18 (94,4)	4/17 (23,5)	3/15 (20,0)	1/2 (50,0)	0/4 (0,0)	6/16 (37,5)	SD	SD	SD	17/18 (94,4)	0/1 (0,0)	1/2 (50,0)	4/12 (33,3)
	Blood	5 (15,2)	0/3 (0,0)	3/5 (60,0)	1/4 (25,0)	0/2 (0,0)	1/3 (33,3)	0/3 (0,0)	1/4 (25,0)	SD	SD	SD	3/5 (60,0)	SD	1/3 (33,3)	1/3 (33,3)
	All	33 (100,0)	3/24 (12,5)	28/33 (84,9)	6/31 (19,4)	4/25 (16,0)	3/14 (21,4)	0/10 (0,0)	8/30 (26,7)	SD	SD	SD	21/25 (84,0)	0/9 (0,0)	7/13 (53,9)	6/23 (26,1)

*SD: No susceptibility data

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Tabla 5. Sensitivity profile of A. baumannii complex and P. aeruginosa of the microbial isolates of patients from the critical care units of the Lambayeque Regional Hospital, 2019-2020, according to sample type

Microorganism	Sample	N (%)	Antibiotics												
			Ampicilina-sulbactam(%)	Amikacina(%)	Cefepime (%)	Ceftriaxona (%)	Ciprofloxacina (%)	Colistina (%)	Gentamicina (%)	Imipenem (%)	Meropenem (%)	Moxifloxacino(%)	Piperacilina / tazobactam (%)	Tobramicina (%)	Trimetrim/sumetoxol (%)
A. baumannii complex	RT	77 (83,7)	8/63 (12,7)	17/72 (23,6)	9/74 (12,1)	2/45 (4,4)	9/74 (12,1)	30/30 (100,0)	9/73 (12,3)	9/71 (12,7)	8/73 (11,0)	1/10 (10,0)	3/25 (12,0)	6/37 (16,2)	7/71 (9
	Blood	6 (6,5)	0/3 (0,0)	2/6 (33,3)	0/5 (0,0)	0/1 (0,0)	0/6 (0,0)	4/4 (100,0)	0/6 (0,0)	0/4 (0,0)	0/6 (0,0)	0/2 (0,0)	0/4 (0,0)	0/2 (0,0)	0/6 (0,(
	Others	9 (9,8)	1/7 (14,3)	2/9 (22,2)	0/9 (0,0)	0/3 (0,0)	0/9 (0,0)	2/2 (100,0)	0/8 (0,0)	0/9 (0,0)	0/7 (0,0)	0/1 (0,0)	0/5 (0,0)	2/6 (33,3)	0/9 (0,(
P. aeruginosa	All	92 (100,0)	9/73 (12,3)	21/87 (24,1)	9/88 (10,2)	2/49 (4,1)	9/89 (10,1)	36/36 (100,0)	9/87(10,3)	9/84 (10,7)	8/86 (9,3)	1/13 (7,7)	3/34 (8,8)	8/45 (17,8)	7/86 (8
	RT	43 (93,5)	0/6 (0,0)	25/40 (62,5)	18/41 (43,9)	SD	19/42 (45,2)	10/10 (100,0)	20/41 (48,8)	20/42 (47,6)	18/39 (46,1)	2/5 (40,0)	7/16 (43,7)	11/18 (61,1)	SD
	Blood	3 (6,5)	0/1 (0,0)	0/2 (0,0)	0/2 (0,0)	SD	0/3 (0,0)	2/2 (100,0)	0/3 (0,0)	0/3 (0,0)	0/2 (0,0)	SD	0/2 (0,0)	0/1 (0,0)	SD
	Others	46 (100,0)	0/7 (0,0)	25/42 (59,5)	18/43 (41,9)	SD	19/45 (42,2)	12/12 (100,0)	20/44 (45,5)	20/45 (44,4)	18/41 (43,9)	2/5 (40,0)	7/18 (38,9)	11/19 (57,9)	SD

*SD: No sensitivity data

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Finally, Table 5 shows that the isolates of P. aeruginosa were sensitive to amikacin and gentamicin. The two microorganisms were fully sensitive to colistin.

Isolates of Acinetobacter baumannii complex showed high resistance to carbapenems such as meropenem and imipenem. The resistance for P. aeruginosa was 42.1% for tobramycin; 48.8% for meropenem; 53.3% for ciprofloxacin; 55.6% for imipenem; 55.8% for cefepime and finally 61.1% for Piperacillin / tazobactam.

Regarding the susceptibility profile of the isolated fungi, a sensitivity of more than 90% was obtained for fluconazole and voriconazole.

DISCUSSION

This study describes the microbiological profile of the microorganisms isolated from patients in the critical care units of the HRL from 2019 to 2020. The male sex predominated with 51.1%, compared to the studies carried out in Colombia and India. Which reported the female sex with 51.6%[8] and 64.0%[9], respectively.

The most frequently obtained culture-positive samples were bronchial secretion and urine culture, representing more than 50% of the total, with similar results to a study conducted in Arequipa[12]; In contrast, two studies in Colombia obtained a higher frequency in blood culture samples[8] and tracheal secretion[13]. It is observed that respiratory tract infections are more prevalent at the national level than systemic infections.

A. baumannii complex and P. aeruginosa were the most frequently isolated species, unlike a study conducted in India that reported S. aureus and K. pneumoniae[7]. On the other hand, two studies in Colombia reported E. coli as the most frequent species in the critical care unit[8-13]. Other studies carried out in Peru reported P. aeruginosa and E. coli as the most frequent species (Arequipa)[12]; while K. pneumoniae turned out to be the most frequent species in a hospital in Lambayeque[9].

When analyzing the E. coli a sensitivity of 100% was obtained for meropenem and 96.3% for ertapenem, similar to a study carried out in Colombia[8], and another in Lambayeque, where the sensitivity was more than 96%. for carbapenems. For the group of aminoglycosides (amikacin) the response was maintained as reported in a hospital in Lambayeque[9].

strains E. coli presented a 94.7% resistance to ampicillin, 88.9% for cefazolin; 79.3% for trimethoprim/sulfamethoxazole with similar results in Colombia[8].

Gram-negative bacilli, mainly enterobacteria, such as E. coli are producers of ESBL enzymes and these are capable of inactivating first and second-generation penicillins and cephalosporins, but also the plasmids that encode ESBLs carry resistance genes to other antimicrobials such as tetracyclines and co-trimoxazole, which is why the phenomenon of cross-resistance is very frequent and the treatment of infections caused by these strains is more difficult[14].

K. pneumoniae presented sensitivities greater than 84.0% for amikacin and meropenem, results that were consistent with previous studies where they presented percentages greater than 60.0%[9] and 100%[8].

Likewise, there were isolates of K. pneumoniae with higher resistance levels for ampicillin/sulbactam, ceftazidime and trimethoprim/sulfamethoxazole compared to those found in studies carried out in Arequipa[12] and Colombia[8,15]. ESBL production constitutes the most frequent mechanism that confers resistance to cephalosporins and other beta-lactams, except carbapenems, in the Klebsiella as shown in this research[16].

Between 75.9% and 91.9% of A. baumannii complex were resistant to amikacin, gentamicin, tobramycin and trimethoprim/sulfamethoxazole, values of lower than 100% resistance for these drugs in a study conducted in Colombia[17]. Carbapenem resistance rates for A. baumannii complex have increased dramatically worldwide, making the antibiotic arsenal more restricted, and clinical practice shifting toward agents such as colistin[18].

The resistance results obtained in the study of P. aeruginosa for cefepime were lower than the results from Arequipa[12] and Colombia[8]. For carbapenems such as meropenem and imipenem, results were well below those obtained in Arequipa[12] and India[7]. 53.3%

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of the isolates were resistant to ciprofloxacin, unlike the high resistance that exists in India [7] and Arequipa [12]. Finally, 61.1% were resistant to piperacillin/tazobactam, while in India and Colombia the values were lower with 30.0% [7] and 50.0% [8], respectively. While a study in Arequipa observed a higher resistance [12].

P. aeruginosa has a high level of intrinsic resistance to various antibiotics and is also capable of acquiring or inducing new resistance, significantly reducing therapeutic options. Intrinsic resistance contributes to resistance to penicillin, aminopenicillins (including combinations with β-inhibitors). lactamases), first, second and third generation cephalosporins, chloramphenicol, nitrofurantoin, sulfonamides, trimethoprim, tetracycline, and ertapenem [19]; however, the available therapeutic options are still effective in our environment.

Being a retrospective study, the limitations that exist are the measurement bias where the data was already measured and recorded by the microbiology laboratory service of the hospital under study. Likewise, the results have limited external validity due to the access restrictions of other hospitals that have intensive care units. However, it provides findings that will allow the initiation of new and larger studies on the subject.

CONCLUSION

In conclusion, the bacteria most frequently isolated from cultures from HRL critical care units in 2019 to 2020 were A. baumannii complex, P. aeruginosa, E. coli and K. pneumoniae. The antimicrobial susceptibility profile of A. baumannii complex showed high resistance to carbapenems and aminoglycosides, but they were sensitive to colistin, as was P. aeruginosa. Meanwhile, E. coli and K. pneumoniae were ESBL in half of their isolates, and showed high sensitivity to amikacin and meropenem.

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Authorship contributions: The authors conceived and designed the study; They also managed the permits and obtained the data to carry out the statistical analysis. They analyzed and interpreted the data and wrote the manuscript. All authors participated in the critical review of the article, approval of the final version and assume responsibility for the content of the article.

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