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Original Article

Indicators of antimicrobial resistance in the intensive care unit of a hospital in Quito, Ecuador

Indicadores de resistencia antimicrobiana en la unidad de cuidados intensivos en un hospital de Quito, Ecuador

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Abstract

Objective: to determine the antimicrobial resistance indicators (prevalence and percentage of resistance) in the intensive care unit of a hospital north of Quito in 2018. **Material and methods:** a non-experimental, descriptive, cross-sectional study was carried out, with a review of clinical data from the clinical records of 99 patients from January 2018 to December 2018 and a registry of 289 samples with 49 positive cultures for bacteria that are part of the component of epidemiological surveillance. **Results:** a prevalence of 15.2% for E. coli ESBL and 7.1% for K. pneumoniae KPC was evidenced. E. coli showed 79% resistance to ceftriaxone as well as 77.8% to cefepime (resistance associated with the presence of ESBL). Likewise, K. pneumoniae presented 60% resistance to third and fourth generation cephalosporins (cefepime, ceftriazone and ceftazidime); with respect to carbapenems, there was 40% resistance for both imipenem and meropenem; while for P. aeruginosa it was 37.5% to ceftazidime in addition to 44% to imipenem, and 38.5% resistance to oxacillin by S. aureus. **Conclusion:** it was determined that the most prevalent bacteria were E. coli and K. pneumoniae with resistance mechanisms mainly associated with beta-lactamase. Indeed, these bacteria are considered in the antimicrobial resistance surveillance component.

Keywords: Bacterial Resistance, Culture, Epidemiology.

Resumen

Objetivo: determinar los indicadores de resistencia antimicrobiana (prevalencia y porcentaje de resistencia) en la unidad de cuidados intensivos en un hospital al norte de Quito en el año 2018.Material y métodos: se realizó un estudio no experimental, descriptivo, transversal, con revisión de datos clínicos de historias clínicas de 99 pacientes desde enero 2018 hasta diciembre 2018 y un registro de 289 muestras con 49 cultivos positivos para bacterias que forman parte del componente de vigilancia epidemiológica. Resultados: se evidenció una prevalencia de 15,2 % para E. coli BLEE y 7,1 % para K. pneumoniae KPC. E. coli mostró un 79 % de resistencia a ceftriaxona, así como un 77,8 % a cefepime (resistencia asociada a la presencia de BLEE). Asimismo, K. pneumoniae presentó un 60 % de resistencia a cefalosporinas de tercera y cuarta generación (cefepime, ceftriazona y ceftazidime); con respecto a carbapenémicos hubo un 40 % de resistencia tanto para imipenem como para meropenem; mientras que para P. aeruginosa fue de 37,5 % a ceftazidime, además de 44 % a imipenem, y 38,5 % de resistencia a oxacilina por parte de S. aureus.Conclusión: se determinó que las bacterias más prevalentes fueron E. coli y K. pneumoniae con mecanismos de resistencia asociados principalmente a betalactamasa. En efecto, se considera a estas bacterias en el componente de vigilancia de resistencia a los antimicrobianos.

Palabras clave: Resistencia Bacteriana, Cultivo, epidemiologí.

Introduction

The antimicrobial resistance indicators allow us to establish profiles of antibiotic susceptibility at the hospital level and to recognize the factors that influence the appearance of health care associated infections (HAI). In addition, they are considered as tools that allow surveillance, prevention, timely recognition and reduction of mortality from IAAS.[1-2].

According to the WHO, the main antibiotic-resistant bacteria are Escherichia coli, Klebsiella pneumoniae, StaphylococcusaureusandStreptococcuspneumoniae, followed by Salmonella spp, microorganisms that are most frequently isolated at the hospital level [3].

The World Health Organization (WHO) and the Center for Disease Control (CDC) focused their attention on IAAS and created the Organization's new Global Surveillance System for Antimicrobial Resistance, known as GLASS for its acronym in English, which aims to combine clinical, epidemiological and laboratory data on the pathogens that pose the greatest threat to global health. These organizations have revealed the widespread presence of antibiotic resistance in samples of 500,000 people from 22 countries with suspected bacterial infections. [3].

Antimicrobial resistance indicators provide the frequency with which a multi-resistant bacterium occurs in each area[4]. Characteristics that not only provide enough information for the development of epidemiological surveillance programs, but also help to detect changes in antibiotic prescription trends over time, in addition to making comparisons between different geographic areas using the same methodology.[5-6].

Consequently, the objective of this research was to determine antimicrobial resistance indicators in patients admitted to the intensive care unit in a hospital north of Quito in 2018.

Materials and methods

A study was conducted non-experimental with a quantitative, cross-sectional, descriptive approach. 99 patients who were admitted to the ICU in a hospital in Quito, Ecuador, in 2018 were included. 289 samples were registered, which met the inclusion criteria for the study. Patients with examinations with records whose reports were incomplete, with negative cultures and duplicate isolates were excluded.

169 positive isolates were considered, showing 49 bacteria from the antimicrobial resistance surveillance component (CVRA), and 120 positive cultures not related to these microorganisms. The microorganisms selected for the study met the following characteristics.

Positive cultures for bacteria that are part of the CVRA such as:

-Enterobacteria (Escherichia coli, Klebsiella spp, Serratia spp,) KPC and ESBL, Vancomycin-resistant Enterococci spp, Staphylococcus aureus resistant to oxacillin, Pseudomonas aeruginosa resistant to piperacillin, ceftazidime, imipenem, meropenem, ciprofloxacin, and amikacin, Acinetobacter spp resistant to merocinaftanemidime, ciprofloxacin / amphiboxane sulphonimidime, ciprofloxacin, and ampipelonemidime sulfate, Candida spp resistant to fluconazole, Clostridium difficile.

-Positive cultures that are not part of surveillance for infection control during an outbreak, examples: nasal and rectal swabs.

The data on the characteristics of the bacteria, types of samples, and date of the sample were registered in the corresponding registry, to later carry out the descriptive statistical analysis with frequencies and percentages.

Results

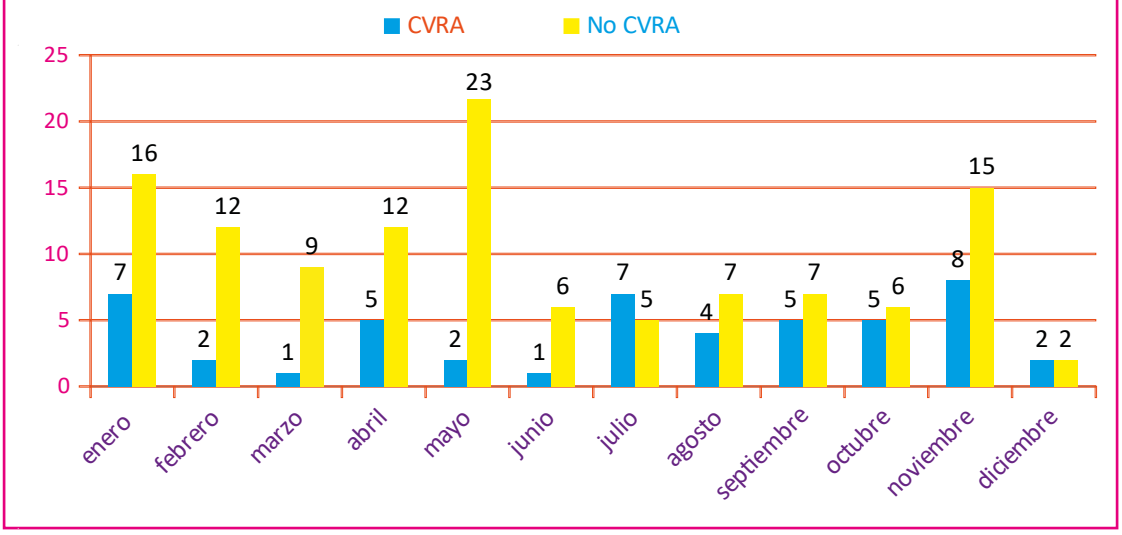
The highest number of pathogenic isolates that are part of the CVRA, (n = 8) 34.8%, corresponded to the month of November, followed by January (n = 7) 30.4% and July with (n = 7) 58, 3 %; In the months of April, October, and September, 5 positive isolates were registered for bacteria that are part of CVRA. Graph 1. In the month of May there was a greater number of positive isolates, a total of 25 isolates. In the month of November, more than one positive isolation was registered for a sample and this is reflected in a percentage greater than 100% (table 1).

Table 1. Microorganisms with positive cultures from samples obtained in the ICU in the hospital north of Quito in 2018

Month	Samples obtained	Positive isolations		Microorganisms			
				CVRA		No CVRA	
		#	%	#	%	#	%
January	29	23	79.3%	7	30.4%	16	69.6%
February	30	14	46.7%	2	14.3%	12	85.7%
March	27	10	37.0%	1	10.0%	9	90.0%
April	19	17	89.5%	5	29.4%	12	70.6%
May	33	25	75.8%	2	8.0%	23	92.0%
June	39	7	17.9%	1	14.3%	6	85.7%
July	25	12	48.0%	7	58.3%	5	41.7%
August	23	11	47.8%	4	36.4%	7	63.6%
September	15	12	80.0%	5	41.7%	7	58.3%
October	18	11	61.1%	5	45.5%	6	54.5%
November	17	23	135.3%	8	34.8%	15	65.2%
December	14	4	28.6%	2	50.0%	2	50.0%
Total	289	169		49		120	

CVRA: Antimicrobial Resistance Surveillance Component

Graphic 1. Positive cultures for microorganisms related or not to CVRA in 2018



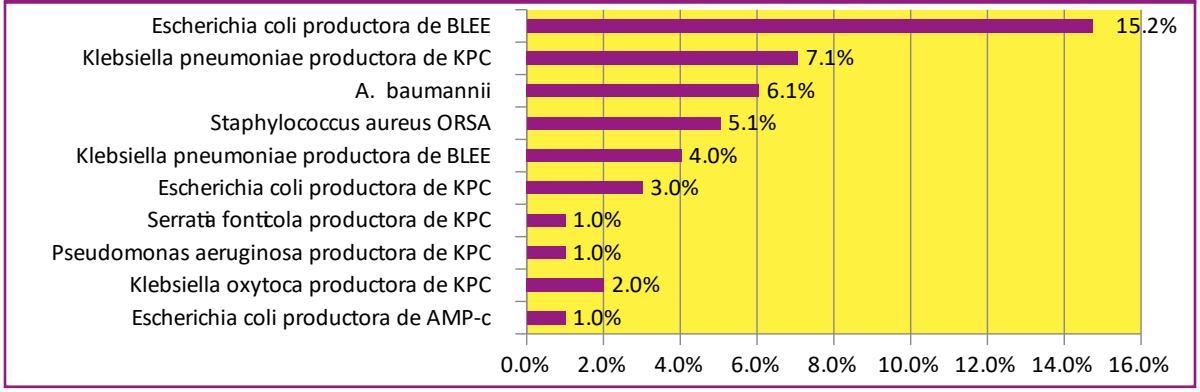
CVRA: Antimicrobial Resistance Surveillance Component

The highest percentage of multiresistant isolates is for E.coli ESBL with (n = 15) 15.2%. Similarly, K. pneumoniae KPC presents a percentage of (n = 7) 7.1%. The rest of bacteria presented less than 5 isolates in the year. Table 2. Graph 2.

Table 2. Prevalence and percentage of multidrug-resistant bacteria in all patients admitted in 2018

Multi- resistant bacteria	n	%
Escherichia coli AMP - c producer	1	1.0%
Klebsiella oxytoca KPC producer	2	2.0%
Pseudomonas aeruginosa KPC producer	1	1.0%
Serratia fonticola KPC producer	1	1.0%
Escherichia coli KPC producer	3	3.0%
Klebsiella pneumoniae ESBL producer	4	4.0%
Staphylococcus aureus ORSA	5	5.1%
Acinetobacter baumannii	6	6.1%
Klebsiella pneumoniae KPC producer	7	7.1%
Escherichia coli ESBL producer	15	15.2%
Total, multi - resistant bacteria	45	45.5%
Total, patients 2018	99	100.0%

Graph 2. Annual prevalence of multidrug-resistant bacteria with respect to the total number of patients admitted in 2018



There was a percentage of bacterial resistance of E. coli for ceftriaxone with 79.2%, cefepime 77.8%, ampicillin 78.6%, ampicillin / sulbactam 67.9%, tetracycline 64.3% (Table 3).

Table 3. Bacterial resistance of E. coli (2018)

Antibiotics	n	S	I	R	NT	Endurance %
Amikacin	29	29	1	1	2	3.4%
Ampicillin	14	3	0	11	17	78.6%
Ampicillin + sulbactam	28	9	0	19	3	67.9%
Cefepime	18	4	0	14	13	77.8%
Ceftriaxone	24	5	0	19	7	79.2%
Ciprofloxacin	31	16	1	14	0	45.2%
Gentamicin	31	28	1	2	0	6.5%
Imipenem	21	18	0	3	10	14.3%
Meropenem	21	18	0	3	10	14.3%
Piperacillin / tazobactam	21	11	2	8	10	38.1%
Tetracycline	14	5	0	9	17	64.3%
Trimethoprim / sulfamethoxazole	19	8	0	11	12	57.9%

In the table 4The sensitivity profile of Klebsiella pneumoniae can be appreciated, such that for ceftazidime, ceftriaxone, and cefepime a (n = 9) 60% resistance was presented. Furthermore, for imipenem and meropenem (n = 6) 40% resistance; the lowest percentages were observed in amikacin and gentamicin with 22.2%.

Table 4. Bacterial resistance of K. pneumoniae (2018)						
Antibiotics	n	S	I	R	NT	Endurance %
Amikacin	18	14	0	4	0	22.2%
Ampicillin + sulbactam	16	7	1	8	2	50.0%
Cefepime	15	6	0	9	3	60.0%
Ceftazidime	15	6	0	9	3	60.0%
Ceftriaxone	15	6	0	9	3	60.0%
Ciprofloxacin	18	11	0	7	0	38.9%
Gentamicin	18	14	0	4	0	22.2%
Imipenem	15	9	0	6	3	40.0%
Meropenem	15	9	0	6	3	40.0%
Piperacillin / tazobactam	15	11	0	4	3	26.7%
Trimethoprim / sulfamethoxazole	9	6	0	3	9	33.3%

n = number; S: sensitive; I: intermediate; R: resistance; NT: not tested

For Pseudomonas aeruginosa, the percentage of resistance in third generation cephalosporins was 37.5%, and in carbapenem imipenem "the antibiotic tested" was 44.4% (Table 5).

Table 5. Bacterial resistance of P. aeruginosa (2018)						
Antibiotics	n	S	I	R	NT	Endurance %
Amikacin	9	9	0	0	0	0.0%
Cefepime	9	7	0	2	0	22.2%
Ceftazidime	8	5	0	3	1	37.5%
Ciprofloxacin	9	8	0	1	0	11.1%
Gentamicin	9	9	0	0	0	0.0%
Imipenem	9	5	0	4	0	44.4%
Meropenem	9	5	2	2	0	22.2%
Piperacillin / tazobactam	8	6	0	2	1	25.0%

n = number; S: sensitive; I: intermediate; R: resistance; NT: not tested

The species S. aureus presented resistance to oxacillin with (n = 5) 38.5% and to erythromycin (n = 6) 46.2% (table 6).

Table 6. Bacterial resistance of S. aureus (2018)						
Antibiotics	**n**	**S**	**I**	**R**	**NT**	**Endurance %**
Ciprofloxacin	15	12	0	3	2	20.0%
Clindamycin	15	12	0	3	17	20.0%
Erythromycin	13	7	0	6	3	46.2%
Gentamicin	13	11	0	2	13	15.4%
Linezolid	10	10	0	0	7	0.0%
Oxacillin	*13*	*8*	*0*	*5*	*0*	38.5%
Rifampicin	10	11	0	2	0	20.0%
Trimethoprim / sulfamethoxazole	14	11	1	2	10	14.3%
Vancomycin	10	10	0	0	5	0.0%

n = number; S: sensitive; I: intermediate; R: resistance; NT: not tested

The lowest percentages of resistance were observed for both ceftazidime and tigecycline with 17% for both antibiotics. On the other hand, carbapenems (imipenem and meropenem) showed percentages greater than 80% (table 7).

Table 6. Bacterial resistance of S. aureus (2018)						
Antibiotics	**n**	**S**	**I**	**R**	**NT**	**Endurance %**
Amikacin	6	3	0	3	0	50.0%
Gentamicin	6	0	0	6	0	100%
Ceftazidime	6	2	3	1	0	17%
Imipenem	6	1	0	5	0	83%
Meropenem	6	0	0	6	0	100%
Tigecycline	6	0	5	1	10	17%

n = number; S: sensitive; I: intermediate; R: resistance; NT: not tested

Discussion

The higher frequency of resistance of CVRA bacterial species stands out in the present analysis: E. coli, K. pneumoniae, S. aureus, P. aeruginosa and A. baumanni complex. Microorganisms that in many cases presented resistance mechanisms, such as extended spectrum beta-lactamases, carbapenemases or resistance genes that minimize the therapeutic options with antibiotics. In general terms, ESBL-producing E. coli is a bacterium that manifests complications in ICU, in addition to being able to acquire genes and present resistance to quinolones, as detailed in his study carried out by Maza at the Eugenio Espejo Specialty Hospital . In general terms, it reported 20.72% of Escherichia coli, a producer of ESBL with resistance to ciprofloxacin (2nd generation quinolone)[7]. Results that partially coincide with our study, which reported 15.2%Escherichia coli, a producer of ESBL that shows resistance.

In the present investigation, the species S. aureus presented oxacillin resistance with (n = 5) 38.5%, in comparison with the work carried out by Morales at the Carlos Andrade Marín Hospital, in which the resistance of Staphylococcus aureus to oxacillin was 47.8%[8]. Our study coincides with results obtained by the National Institute for Public Health Research INSPI, which details a resistance of Staphylococcus aureus to oxacillin of 39.7%[9].

At the General Teaching Hospital of Calderón, resistance to Escherichia coli was reported. In fact, it highlighted the resistance to antibiotics: ampicillin 67%, ceftriaxone 48%, ceftazidime 48%, ciprofloxacin 54%, trimethoprim / sulfamethoxazole 52%, ampicillin / sulbactam 51%[11], percentages similar to those presented in our study.

The results of this research, regarding percentages of resistance, are in agreement with the National Reference Center for Antimicrobial Resistance (CRN-RAM) National Institute for Public Health Research - Dr. Leopoldo Izquieta Pérez, especially for Pseudomonas aeruginosa, However, the number of bacteria with which we worked was low and this could present bias at the time of comparison between data. For Pseudomonas aeruginosa, the percentage of resistance in third-generation cephalosporins was 37.5%, and in carbapenem imipenem "the antibiotic tested" was 44.4%. It should be noted that the most recommended antibiotics for the treatment of P. aeruginosa are gentamicin and ciprofloxacin, since these microorganisms do not present resistance or are more sensitive to this group of drugs.[10] The rest of bacteria such as Serratia fonticola and Klebsiella oxytoca are bacteria that, according to the CRN-RAM, correspond to resistant microorganisms that have been reported in smaller quantities, which is why no resistance data have been collected. However, due to the great breadth of gene acquisition, evolution, and adaptation of these microorganisms (Serratia fonticola and Klebsiella oxytoca), their epidemiological surveillance is necessary. The number of bacterial infections under epidemiological surveillance is higher in unprecedented places of this type of microorganism. Due to individuals carrying these pathogens who are in contact with many patients or people with risk factors for the acquisition of these bacteria. [4-10].

In order to reduce the number of infections by multi-resistant bacteria, early and timely alert and response protocols have been created to events with a high epidemic potential that could trigger emergencies[11].Among the microorganisms that constantly acquire resistance is E. coli, so in 2017 the National Institute for Public Health Research showed a 56.90% resistance to ciprofloxacin for E. coli, compared to our corresponding research to 45.2%. It should be noted that our population was smaller than that of work in comparison. On the other hand, A. baumannii complex was the bacterium that prevailed in January, because of several cases of colonized and asymptomatic patients that infected patients with different risk factors.

conclusion

A high percentage of bacterial resistance is evidenced in samples taken from ICU patients of a hospital in Quito, Ecuador. It was determined that the most prevalent bacteria were E. coli and K. pneumoniae with resistance mechanisms mainly associated with beta-lactamase. Indeed, these bacteria are considered in the antimicrobial resistance surveillance component; Indicators such as prevalence and percentage of resistance provide updated information to epidemiological surveillance systems.

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