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Antibacterial Resistance Patterns of WHO List of Essential Antibiotics Adopted by Mozambique

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Abstract

Background: Combating antibiotic resistance is a high priority for the World Health Organization (WHO). In order to optimize the use of antimicrobials and ensure sustainable investment in the fight against antimicrobial resistance, the WHO has updated the 19th List of Essential Medicines (EML) with new recommendations on antibiotic use by 2017. Since the launch of the first Model of the WHO EML in 1977, many countries adopted the concept of essential medicines and developed their own lists. Mozambique published its first edition in May 2017. To our knowledge, this study is the first to analyzing the antibacterial resistance pattern of the National List of Essential Medicines (EMNL) against bacteria isolated from patients admitted to the Intensive Care Unit (ICU) of the Central Hospital of Maputo (HCM) in 2017.

Methods: This was a cross-sectional, epidemiological, quantitative approach, with a retrospective analysis of secondary data, performed at the ICUs in Maputo Central Hospital.

Results: The mean resistance was 62.4%, 63.2% in the ICU-Pediatrics and 60.2% in the ICU-Adults. In ICU-Pediatric, the beta-lactams had a resistance of 69.3%, being higher in Gram-positive (75.8%) and Enterobacteriaceae (74.2%). In this class of antibiotics, the penicillins and cephalosporins presented high resistance rates with 80.6% and 78.6%, respectively; Carbapenems showed good antibiotic activity with a sensitivity of 73.6%. In ICU-Adults, the penicillins presented a good antibiotic activity against the isolated bacteria, with more prominence the cloxacillin with resistance ratio of 4.8%; in this sector, cephalosporins (70.0%), quinolones (81.8%), aminoglycosides (69.9%) and macrolides (69.6%) were the classes of antibiotics with high resistance rates.

Conclusion: There is a need for EMNL to be updated with the introduction of new drugs considered as last resort options and used only under the most severe circumstances when all alternatives failed.

Keywords: Bacteria; Antibacterial resistance; List of essential antibiotics; Mozambique

Introduction

Antibiotic resistance is rising to dangerously high levels in all parts of the world. New mechanisms of resistance are emerging and spreading globally, threatening the human capacity to treat common infectious diseases [1]. According to Centers for Disease Control and Prevention (CDC) (2013) [2], without urgent action against antibiotic resistance, mankind is moving into a post-antibiotic era in which common infections and minor injuries can once again be lethal. Given the ease and frequency with which people travel today, resistance to antibiotics is a global problem, requiring the efforts of all nations and many sectors [3].

Combating antibiotic resistance is a high priority for the World Health Organization (WHO). A global action plan on antimicrobial resistance, including antibiotic resistance, was endorsed by the World Health Assembly in May 2015 to ensure the prevention and treatment of infectious diseases with safe and effective medicines [4]. In order to optimize the use of antimicrobials and ensure sustainable investment in the fight against antimicrobial resistance, the WHO updated the 19th List of Essential Medicines (EML) with new recommendations on the use of antibiotics for 2017 [3].

Since the launch of the first WHO Model of EML in 1977, many countries have adopted the concept of essential medicines and developed their own lists, with Mozambique being issued its first edition in May 2017 to ensure that antibiotics are available when needed and that certain antibiotics are prescribed for the right infections [5]. The goal is to improve treatment outcomes, reduce the development of drug-resistant bacteria, and preserve the effectiveness of the antibiotics of last resort, which are needed when all others fail [6].

Considering the above, this study aims to analyze the antibacterial resistance pattern of the National List of Essential Medicines (EMNL) against bacteria isolated from patients admitted to the Intensive Care Unit (ICU) of the Central Hospital of Maputo (HCM) in the year 2017.

Materials and Methods

This was a retrospective, descriptive cross-sectional, epidemiological, quantitative study of data obtained from the HCM Microbiology Laboratory. The study was carried out in the Pediatrics ICU, Medicine ICU and Surgical ICU at HCM from January to December 2017, with the data from latter consolidated. HCM is a quaternary public and teaching hospital with about 1463 beds, provides 4 Intensive Care Services: the Emergency ICU with 16 beds, the Medicine ICU with 6 beds, the Pediatrics ICU with 16 beds and the Surgical ICU with 12 beds. During the study period, 1913 patients of all ages and both sexes were admitted to HCM ICUs, including 1129 in the Pediatrics ICU, 355 in the Medicine ICU and 429 in the Surgical ICU [7].

Data on the profile of etiological agents was extracted from the WHONET electronic database of the HCM Microbiology Laboratory which was set up at the end of October 2009 in order to monitor antimicrobial resistance in bacteria isolated from routine clinical samples. The database contains information on the specimens taken, patient details, growth or non-growth of infectious agents, the bacteria isolated, antibiotic sensitivity, as well as data from the patient justifying examination [8].

A descriptive statistical analysis was performed using graphs and frequency tables to understand the behavior of the variables under study. Data analysis was done with the Statistical Package for Social Sciences (SPSS) version 20 and BioEst version 5.2. The Z-test or Standardized Score was used for the comparison of proportions and the P-value of less than 0.05 was considered significant. Before conducting data analysis, a request for authorization of the research was submitted to the HCM Scientific and Pedagogical Department under reference number 321/024/DCIEFHCM/18. After authorization of the research request, the project was submitted to the ISCISA Institutional Health Bioethics Committee and approved under reference number TFCMCSFM05/18. The study complied with the 2013 Helsinki Declaration on health research standards. For the antibiotic resistance standards of the isolated etiological agents, the categories of sensitive (S), Intermediate (I) and Resistant (R) were considered by obeying the inhibition halo diameters based on the standardization proposed by the Clinical and Laboratory Standards Institute [9].

Results

According to the data in Tables 1 and 2, 131 patients with bacteriological infections were identified in the study period, 74.8% of which were in pediatric patients and 25.2% were adults. The majority of the patients were males with a percentage of 52.7%. For the analysis of age, Pediatrics ICU patients were divided into: infants (1 month to 1 year), pre-school (2 to 5 years), schoolchildren (6 to 10 years) and adolescents (11 to 16 years). According to Table 1, of the 98 patients from the Pediatrics ICU, 51% are infants, 31.6% are preschool, 10.2% are school children and 7.2% are adolescents. Analyzing the individual age groups, we observed the predominance of males among infants, pre-school and school children. In adolescents the majority were female. The mean age was 3.1 years (3.1 ± 0.7) and median 1.8 years. Most patients were 2 years old, with the oldest patient being 15 years old and the youngest 1 month old, with no significant difference between the sexes. According to Table 2, of the 33 patients from the ICU-Adults, the majority are male (57.6%). The mean age is 42.7 years and median age is 42 years. Most patients are 69 years old of age, having the oldest patient 69 years, and the younger 16 years old. The Male patients have a mean age of 48.8 years and female patients 36.1 years, and this difference is significant (p=0.0145).

Age group	Gender		Sum n (%)	Z	P-Value
	Masculine n (%)	Feminine n (%)			
Pediatrics	50 (51.0)	48 (49.0)	98 (74.8)	-	-
Infants	26 (51.0)	23 (48.9)	49 (50.0)	0.2022	0.8398
Preschool	18 (35.3)	13 (27.7)	31 (31.6)	0.8119	0.4168
School	3 (5.9)	7 (14.9)	10 (10.2)	1.4723	0.1409
Adolescents	4 (7.8)	4 (8.5)	8 (8.2)	0.1206	0.904
Sum	51 (52.0)	47 (48.0)	98 (74.8)	-	

Table 1: Distribution of patients by sex and age group (pediatrics ICU).

Gender	Age					
	N (%)	Mean	S Deviation	$IC_{95\%}$	T-student	P-Value
Feminine	14 (42.4)	36.1	13	(36.1 ± 7.3)		
Masculine	19 (57.6)	48.8	14.3	(48.8 ± 7.1)		
Sum	33 (25.2)	42.7	15.04	(42.7 ± 5.2)	2.5922	0.0145

Table 2: Distribution of patients by sex and age group (Adults ICU).

According to the data in Table 3, 179 cultures were identified positive to bacteria, being most isolated from the Gram-negative ones with percentage of 69.3% compared to 30.7% of Gram-positive. Among Gram-negative bacteria, Enterobacteriaceae family bacteria were more prevalent with 41.9%. In the Pediatrics ICU, 127 (70.9%) cultures were positive for bacteria, 37.8% Enterobacteriaceae, 32.3% Non-Fermenting Gram-Negative Bacilli (NFGNB) and 29.9% Gram-Positive bacteria. In adults, of the 52 (29.1%) isolated cultures, 51.69% were from the Enterobacteriaceae family, 32.7% Gram-positive bacteria and 13.4% NFGNB.

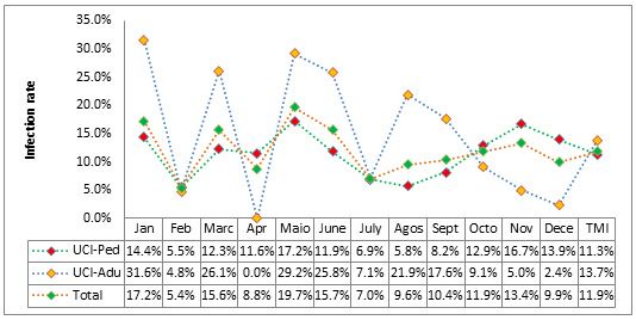
Gram Staining				
	Positives	Negatives		Sum
		Enterobacteriaceae	NFGNB	
ICU type	n (%)	n (%)	n (%)	n (%)
Pediatric	38 (29.9)	48 (37.8)	41 (32.3)	127 (70.9)
Adults	17 (32.7)	27 (51.9)	8 (13.4)	52 (29.1)
Sum	55 (30.7)	75 (41.9)	49 (27.4)	179 (100.0)

Table 3: Distribution of infectious bacteria for gram staining and ICU type.

According to Chart 1, the rate of infection in the Pediatrics ICU was 11.3% in a ratio of 1.3 (127/98) infection per patient, with May, November, January and December registering high rates with 17.2%, 16.7% , 14.4% and 13.9%, respectively. The months of October, March, June and April also registered rates above the average of 12.9%, 12.3%, 11.9% and 11.6% respectively. In this sector, the lowest rates were recorded in February (5.5%), August (5.8%), July (6.9%) and September (8.2%).

In Adults ICU, the overall infection rate was 13.7% at a ratio of 1.6 (49/30) infection per patient, with January (31.6%), May (29.5%), March (26.1%), August (21.9%) and September (17.6%) registered high rates. The months of December (2.4%), February (4.8%), November (5%), July (7.1%) and October (9.1%) had below average infection rates. The month of April did not register any case of infection in the Adults ICU.

Thus, the mean infection rate in HCM ICUs was 11.9% in 2017, with May (19.7%), January (17.2%), June (15.7%), March (15.6%), November 13.4%) recorded above-average rates (Figure 1).



	Jan	Feb	Marc	Apr	Maio	June	July	Agos	Sept	Octo	Nov	Dece	TMI
UCI-Ped	14.4%	5.5%	12.3%	11.6%	17.2%	11.9%	6.9%	5.8%	8.2%	12.9%	16.7%	13.9%	11.3%
UCI-Adu	31.6%	4.8%	26.1%	0.0%	29.2%	25.8%	7.1%	21.9%	17.6%	9.1%	5.0%	2.4%	13.7%
Total	17.2%	5.4%	15.6%	8.8%	19.7%	15.7%	7.0%	9.6%	10.4%	11.9%	13.4%	9.9%	11.9%

Figure 1: Monthly and general distribution of the infection rate by type of ICU.

Table 4 shows the results of the resistance to EMNL of bacteria isolated in the Pediatrics ICU.

The beta-lactams had a resistance of 69.3%, being higher in Gram-positive (75.8%) and Enterobacteriaceae (74.2%). In this class of antibiotics, the penicillins and cephalosporins presented high resistance rates with 80.6% and 78.6%, respectively. Carbapenems showed good antibiotic activity with a sensitivity of 73.6%.

Gentamicin presented a mean resistance of 70.6%, with the lowest in Gram-positive bacteria isolates with a percentage of 52.6%, NFGNB (64%) and Enterobacteriaceae (91.7%).

Ciprofloxacin was the most tested antibiotic, presenting a mean resistance of 63.5%. This antibiotic had the highest resistance in Enterobacteriaceae with a percentage of 61.1%.

Vancomycin had a resistance of 66.7% and was only tested on Gram-positive bacteria.

In macrolides, azithromycin did not inhibit growth of any bacterial strain and erythromycin showed a resistance of 59.3%.

Clindamycin was only tested on Gram-positive bacteria, presenting a resistance of 34.5%.

Co-trimoxazole showed an average resistance of 85.1%, 91.7% in Enterobacteriaceae, 87.5% in NFGNB and 73.3% in Gram-positive bacteria.

Chloramphenicol was the second antibiotic most tested in bacteria isolated in the Pediatrics ICU, presenting an average resistance of 44.3%. This antibiotic showed good antibiotic activity against Gram-positive bacteria and Enterobocteriaceae with sensitivity of 83.7% and 65.4%, respectively.

The antibiotic resistance of the EMNL of bacteria isolated in the Pediatrics ICU was 63.2%, being Enterobacteriaceae (70.2%), NFGNB (62.1%) and Gram-positive bacteria (56%).

EMNL Antibiotics Tested	Family of bacteria							
	Bacteria Gram +		Enterobacteriaceae		NFGNB		Sum	
	N	n (Res%)	N	n (Res%)	N	n (Res%)	N	n (Res%)
Beta-lactams	62	47 (75.8)	124	92 (74.2)	88	51 (58.0)	274	190 (69.3)
Penicillin's	42	34 (81.0)	38	32 (84.2)	13	9 (69.2)	93	75 (80.6)
Amoxicillinn	2	2 (100.0)	10	8 (80.0)	2	2 (100.0)	14	12 (85.7)
Ampicillin	10	8 (80.0)	28	24 (85.7)	11	7 (63.6)	49	39 (79.6)
Cloxacillin	1	1 (100.0)					1	1 (100.0)
Penicillin G	29	23 (79.3)					29	23 (79.6)
Cephalosporin's	15	11 (73.3)	66	55 (83.3)	47	35 (74.5)	128	101 (78.9)
Cephalexin	1	1 (100.0)	1	1 (100.0)			2	2 (100.0)
Cefazolin	1	1 (100.0)	2	2 (100.0)	1	0 (0.0)	4	3 (75.0)
Ceftriaxone	6	3 (50.0)	22	19 (86.4)	23	20 (87.0)	51	42 (82.4)
Cefotaxime	4	3 (75.0)	15	14 (93.3)	6	5 (83.3)	25	22 (88.0)

Ceftazidime	3	3 (100.0)	26	19 (73.1)	17	10 (58.8)	46	32 (69.6)
Carbapenem	5	2 (40.0)	20	5 (25.0)	28	7 (25.0)	53	14 (26.4)
Imipenem	5	2 (40.0)	20	5 (25.0)	28	7 (25.0)	53	14 (26.4)
Aminoglycosides	19	10 (52.6)	24	22 (91.7)	25	16 (64.0)	68	48 (70.6)
Gentamicin	19	10 (52.6)	24	22 (91.7)	25	16 (64.0)	68	48 (70.6)
Quinolones	23	11 (47.8)	36	22 (61.1)	36	21 (58.3)	85	54 (63.5)
Ciprofloxacin	23	11 (47.8)	36	22 (61.1)	36	21 (58.3)	85	54 (63.5)
Glycoptides	6	2 (33.3)					6	2 (33.3)
Vancomycin	6	2 (33.3)					6	2 (33.3)
Macrolides	28	17 (60.7)	1	1 (100.0)			29	18 (62.1)
Azithromycin	1	1 (100.0)	1	1 (100.0)			2	2 (100.0)
Erythromycin	27	16 (59.3)					27	16 (59.3)
Lincosamides	29	10 (34.5)					29	10 (34.5)
Clindamycin	29	10 (34.5)					29	10 (34.5)
Sulfonamides	15	11 (73.3)	24	22 (91.7)	8	7 (87.5)	47	40 (85.1)
Co-trimoxazol	15	11 (73.3)	24	22 (91.7)	8	7 (87.5)	47	40 (85.1)
Others	25	8 (32.0)	33	11 (33.3)	17	13 (76.5)	75	32 (42.7)
Chloramphenicol	19	5 (26.3)	26	9 (34.6)	16	13 (81.3)	61	27 (44.3)
Nitrofurantoin	6	3 (50.0)	7	2 (28.6)	1	0 (0.0)	14	5 (35.7)
Sum	207	116 (56.0)	242	170 (70.2)	174	108 (62.1)	623	394 (63.2)
N=Total strains tested; n= Total resistant strains; %Res= Percentage of resistant strains.								

Table 4: Pattern of antibiotic resistance of EMNL against bacteria isolated in the pediatrics ICU.

According to Table 5, the bacteria isolated in Adults ICU patients presented resistance to penicillins of 38.3%. In this class of antibiotics, amoxicillin did not inhibit growth of any single bacterial strain. Penicillin G had a resistance of 71.4% and was only tested on Gram-positive bacteria. Cloxacillin was the most tested antibiotic in the class of penicillins and showed good antibiotic activity with a mean sensitivity of 95.2%.

Cephalosporins had a mean resistance of 70% and did not inhibit growth of any single NFGNB strain. In this class of antibiotics, cephalosporins of the 3rd generation presented high resistance indexes, being cefotaxime (78.9%), ceftazidime (72.7%) and ceftriaxone (60%).

Imipinem was more tested in Enterobacteriaceae, presenting a resistance of 57.1%.

Gentamicin was more resistant to Gram-negative bacteria, with Enterobacteriaceae (83.3%) and NFGNB (75%).

Vancomycin, erythromycin and clindamycin were tested in Gram positive bacteria, and presented resistance with 0.0%, 66.47% and 42.9%, respectively.

Chloramphenicol did not inhibit growth of any strain isolated from Enterobacteriaceae and in Gram-positive bacteria and NFGNB the resistance was 55.63% and 50% respectively.

EMNL Antibiotics Tested	Family of bacteria							
	Bacteria Gram+		Enterobacteriaceae		NFGNB		Sum	
	N	n (%)	N	n (%)	N	n (%)	N	n (%)
Beta-lactam	22	13 (59.1)	92	49 (53.3)	21	14 (66.7)	135	76 (56.3)
Penicillin's	10	6 (60.0)	30	11 (36.7)	7	1 (14.3)	47	18 (38.3)
Amoxicillinn			1	1 (100.0)			1	1 (100.0)

Ampicillin	3	1 (33.3)	12	9 (75.0)	3	1 (33.3)	18	11 (61.1)
Cloxacillin			17	1 (5.9%)	4	0	21	1 (4.8)
Penicillin G	7	5 (71.4)					7	5 (71.4)
Cephalosporin's	9	6 (66.7)	48	30 (62.5)	13	13 (100.0)	70	49 (70.0)
Cephalexin			4	2 (40.0)	1	1 (100.0)	5	3 (60.0)
Cefazolin			17	10 (58.8)	2	2 (100.0)	19	12 (63.2)
Ceftriaxone	4	2 (50.0)	1	1 (100.0)			5	3 (60.0)
Cefotaxime	1	1 (100.0)	13	9 (69.2)	5	5 (100.0)	19	15 (78.9)
Ceftazidime	4	3 (75.0)	13	8 (61.5)	5	5 (100.0)	22	16 (72.7)
Carbapenem	2	1 (33.3)	14	8 (57.1)	1	0 (0.0)	17	9 (52.9)
Imipenem	2	1 (50.0)	14	8 (57.1)	1	0 (0.0)	17	9 (52.9)
Aminoglycosides	7	3 (50.0)	12	10 (83.3)	4	3 (75.0)	23	16 (69.6)
Gentamicin	7	3 (50.0)	12	10 (83.3)	4	3 (75.0)	23	16 (69.6)
Quinolones	5	3 (60.0)	5	5 (100.0)	1	1 (100.0)	11	9 (81.8)
Ciprofloxacin	5	3 (60.0)	5	5 (100.0)	1	1 (100.0)	11	9 (81.8)
Glycoptides	4	0 (0.0)					4	0 (0.0)
Vancomycin	4	0 (0.0)					4	0 (0.0)
Macrolides	12	8 (66.7)					12	8 (66.7)
Erythromycin	12	8 (66.7)					12	8 (66.7)
Lincosamides	7	3 (42.9)					7	3 (42.9)
Clindamycin	7	3 (42.9)					7	3 (42.9)
Tetracycline's			1	1 (100.0)	1	1 (100.0)	2	2 (100.0)
Doxycycline			1	1 (100.0)	1	1 (100.0)	2	2 (100.0)
Sulfonamides	2	2 (100.0)	2	0 (0.0)			4	2 (50.0)
Co-trimoxazol	2	2 (100.0)	2	0 (0.0)			4	2 (50.0)
Other	10	5 (50.0)	11	11 (100.0)	2	1 (50.0)	23	17 (73.9)
Chloramphenicol	9	5 (55.6)	10	10 (100.0)	2	1 (50.0)	21	16 (76.2)
Nitrofurantoin	1	0 (0.0)	1	1 (100.0)			2	1 (50.0)
Sum	69	37 (53.6)	123	76 (61.9)	29	20 (68.9)	221	133 (60.2)
N=Total strains tested; n=Total resistant strains; %Res=Percentage of resistant strains.								

Table 5: Antibiotic resistance pattern of MNL against bacteria isolated in adults ICU.

Discussion

In the present study, the mean resistance of bacteria isolated from penicillins was 66.4%, amoxicillin (86.7%), penicillin G (77.7%), ampicillin (74.6%) and cloxacillin 9.1%. These results approximate the findings of Monteiro et al. [8] in patients hospitalized in HCM, where it had an average resistance of 88.8% to amoxicillin and 90.6% to ampicillin. Cloxacillin has shown good antibiotic activity against the etiological agents, as was also verified by Nyasulu et al. [10] in a study conducted in tertiary hospitals in South Africa witch found an average resistance of 15.4% to this antibiotic. Regarding resistance to penicillin G, Van der Meeren et al. [11] a study performed at the Hospital Central da Beira (HCB) found a percentage of 94.9%, which is slightly higher when compared to the findings in this study.

The mean resistance to cephalosporins was 76.3%, with cefotaxime (84.1%), ceftriaxone (80.4%), cephalexin (71.4%), ceftazidime (70.6%) and cefazolin (69.6%). Monteiro et al. [8] found an average resistance

of 37% to cefotaxime and 40.7% to ceftazidime, very low percentages when compared with the findings in this study. The results of the present study corroborate with the findings by Van der Meeren et al. [11], where it found an average resistance of 87.1% to cefazolin and 77.4% to cefotaxime and ceftazidime. The findings of Nyasulu et al. [10] are similar to those of the present study, where ceftriaxone had a mean resistance of 66% and ceftazidime 82%.

In this study the average resistance to imipinem was 32.9%, which is very high when compared with 0.0% found by Van der Meeren et al. [11], 1.9% found by Monteiro et al. [8] and 9% by Nyasulu et al. [10]. In a similar study, Sambyal et al. [12], found a mean resistance to imipenem of 44.3%, a value very close to the findings in the present study.

Gentamicin was the second antibiotic most tested against bacteria isolated in the ICU, having an average resistance of 70.3%, a result similar to 83.9% found by Van der Meeren et al. [11], but different from those found by Monteiro et al. [8] and Nyasuluet et al. [10] in which they obtained percentages of 52% and 52.3% respectively.

Ciprofloxacin was the antibiotic most tested against strains of bacteria isolated in the ICU, having an average resistance of 65.6%, a very high result when compared to Monteiro et al. [8] and Van der Meeren et al. [11] where they obtained percentages of 16.5% and 35.5% respectively.

Vancomycin is specifically used in the treatment of Gram-positive bacilli and, in this study had an average resistance of 20%. These findings are similar to those of Nhantumbo et al. [13] where it obtained resistance with a percentage of 11.8%.

The mean macrolide resistance was 63.4%, being azithromycin (100%) and erythromycin (61.5%). Nhantumbo et al. [13] obtained an average resistance of 23.5% to erythromycin, a very low value when compared to the findings in the present study, but similar to the 34.5% obtained by Nyasulu et al. [10]. Huband et al. [14] in Gram-positive bacteria isolates in the United States of America, obtained a mean resistance ranging from 44.1% to 89.2%.

Nyasulu et al. [10], obtained an average resistance of 32.4% to clindamycin, a result very close to the 36.1% found in the present study. Nhantumbo et al. [13] found a sensitivity to clindamycin of 100%.

Doxycycline was only tested in Adults ICU on Gram-negative bacteria, presenting a resistance of 100%. These findings are significantly different from the results of Zhang et al. [15] and Van der Meeren et al. [11] in which they obtained a resistance to doxycycline with percentage of 70.1% and 58.1% respectively.

In the present study resistance to co-trimoxazole was 82.4%, and was frequently tested in the pediatrics ICU. The results of the present study are similar to those found by Van der Meeren et al. [11], where it obtained a resistance of 71% to co-trimoxazole. Nyasulu et al. [10] obtained an average resistance of 58.1%, which very low value when compared to the findings in the present study.

In this study, the resistance of strains isolated from bacteria to chloramphenicol was 52.4%, which is very low when compared with 93.5% obtained by Van der Meeren et al. [11]. Monteiro et al. [8] found an average resistance of 39.1% to nitrofurantoin a value that is higher than 25% of the present study.

The bacteria isolated in the HCM ICUs presented an average resistance of 62.4%, being slightly higher in pediatric patients.

Conclusions

In this study, it was verified that the EMNL antibiotics present high resistance rates against tested bacteria, with higher Gram-negative percentages. There is a need for EMNL to be updated with the introduction of new drugs considered as last resort options and used only under the most severe circumstances when all alternatives failed. With the development of new antibiotics at a slow pace, regular monitoring of infections and resistance profiles, rational use of antibiotics and standardized measures of infection control can have a major impact on reducing high resistance rates.

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