Magnitude and Trends of Antimicrobial Resistance in Latin America. ReLAVRA 2014, 2015, 2016.

Summary Report

Antimicrobial resistance (AMR) in the Americas

The data presented in this report were collected by the Red Latinoamericana de Vigilancia de la Resistencia a los Antimicrobianos (ReLAVRA by its Spanish acronym), which is coordinated by the Pan American Health Organization (PAHO). The network, established by PAHO in 1996, currently constitutes 19 countries from Latin America, each of which is represented by an officially designated national reference laboratory. The national reference laboratory in each country receives data from sentinel sites and reports aggregated surveillance data, including the total number of isolates per year and the overall percentages of resistance (R) and intermediate resistance (I), to PAHO annually.

This report summarizes AMR data from 2014 to 2016. In 2016, a total of 15 countries in the Americas reported data to ReLAVRA: Argentina, Bolivia, Brazil, Colombia, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru, and Venezuela. The report provides analyses of data on six selected pathogens of public health importance in humans: *Klebsiella pneumoniae, Escherichia coli, Acinetobacter baumannii, Staphylococcus aureus, Pseudomonas aeruginosa,* and *Neisseria gonorrhoeae*. The Cochran-Armitage trend test was used to identify significant temporal trends. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis. These aggregated data allow the understanding of magnitude of the trends in laboratory isolates captured by the national resistance surveillance systems and are reliable for knowing the trends of AMR in the region. It is a wake-up call for proposing or defining containment strategies in the region.

The aggregated surveillance data have several limitations. First of all, the epidemiological information collected (e.g., information on patient characteristics) is limited. Furthermore, the geographic and demographic representativeness of the data are unknown. To overcome such limitations and further strengthen the AMR surveillance systems in the region, PAHO launched an enhanced surveillance initiative in 2019. The initiative aims to collect AMR data at the isolate-level, in addition, it will also expand the geographic scope to English-speaking Caribbean countries

A series of interactive ReLAVRA data visualizations are available at https://www.paho.org/en/topics/antimicrobial-resistance.

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Key summary

- Strengthening AMR surveillance is one of the five key strategic objectives outlined in the global and regional action plans; this is essential for increasing awareness regarding the problem and informing AMR prevention actions, treatment guidelines, and patient safety measures.
- The aggregated data allow us to understand the magnitude of resistance in the laboratory isolates captured by the national resistance surveillance systems, and although they are reliable to show the trends of AMR in the region, data for additional years will make the trend analysis more robust.
- The significant difference in nonsusceptibility percentages observed among countries in the region require further investigation to identify the reasons behind and formulate better responses.
- During the reporting period , a total of 15 countries in the region reported AMR data to ReLAVRA: Argentina, Bolivia, Brazil, Colombia, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru, and Venezuela.
- For *Klebsiella pneumoniae,* an average of 2,462 isolates submitted to ReLAVRA per year between the reporting period. There is a variability in the percentage of nonsusceptibility from 1% to 36%. Overall, the percentage of nonsusceptibility to carbapenems at the regional level increased significantly between 2014 and 2016. Eight of 14 countries have shown increasing trends in nonsusceptibility to carbapenems.
- For *Escherichia coli*, 15 countries submitted data regarding susceptibility to third-generation cephalosporins between 2014 and 2016. Among these countries, the percentage of nonsusceptibility to third-generation cephalosporins ranged from 0% to 60%. Resistance to carbapenems remains low in the region, with a percentage of nonsusceptibility below 7% in almost all countries.
- For *Acinetobacter baumannii*, an average of 967 isolates (range= 9 to 8,327) were reported by 15 countries between 2014 and 2016. The percentage of nonsusceptibility to carbapenems ranged from 8% to 89% over time. Overall, countries in the region have shown high resistance to carbapenems. More than a 50% level of nonsusceptibility was observed in 10 countries in 2016. Between 2014 and 2016, four countries exhibited significant increasing nonsusceptibility trends, while six countries showed decreasing trends.
- For *Staphylococcus aureus*, 15 countries reported antimicrobial susceptibility results from an average of 2166 nosocomial isolates to ReLAVRA between 2014 and 2016. More than half (n=11) of the countries have reported MRSA (methicillin-resistant Staphylococcus aureus) percentages above 50% during the reporting period. Three countries showed significant increases in MRSA percentages between 2014 and 2016, while five countries exhibited decreasing trends.
- For *Pseudomonas aeruginosa*, an average of 2078 isolates were reported by 15 countries to ReLAVRA between 2014 and 2016. The percentage of nonsusceptibility to carbapenems ranged from 17% to 74%. Between 2014 and 2016, four countries showed significant increases in nonsusceptibility and three exhibited decreasing trends.
- Comparing with other pathogens, data regarding *Neisseria gonorrhoeae* susceptibility are relatively limited in the region. During the reporting period, an average of 134 isolates were reported to ReLAVRA per country per year. Argentina and Chile reported data continuously for three years. Both countries showed increasing temporal trends in nonsusceptibility to ciprofloxacin that allow the update of the national treatment guidelines. The data regarding *Neisseria gonorrhoeae* susceptibility are crucial to the countries in the region to select appropriate antibiotics for treatment of STIs.

Klebsiella pneumoniae

Klebsiella pneumoniae causes pneumonia, urinary tract infections, bacteremia, and sepsis *(1)*. It is a common cause of infection in susceptible populations such as the elderly, neonates, diabetic patients, and immunosuppressed individuals. Beta-lactams are the antibiotic of choice for treating *Klebsiella pneumoniae* infections; however, the appearance of beta-lactam-resistant strains has left carbapenems as the only treatment alternative *(2)*. Moreover, the spread of carbapenem-resistant strains since 1996 has significantly complicated treatment *(3)*. Higher mortality has been observed in carbapenem-resistant strains (42%) than in carbapenem-sensitive strains (21%) *(4)*. *Klebsiella* spp. can survive on inert surfaces for months and thereby cause the extension of resistant strains in hospitals as well as the appearance of epidemic outbreaks *(5)*.

Trends in AMR

In 2016, 14 countries reported data on carbapenem susceptibility to ReLAVRA. Of the 40,112 isolates submitted, 8,531 (21%) were shown to have nonsusceptibility to carbapenems. The percentage of nonsusceptibility varied between 1% in Bolivia (13/1,280) and the Dominican Republic (3/274) to 32% in Cuba (10/31) and Honduras (4,947/15,459). Eight countries have shown significant temporal trends over three years, with seven of these countries exhibiting increasing trends in nonsusceptibility (Argentina, Colombia, Cuba, Ecuador, Paraguay, Peru, and Venezuela) and one country (Nicaragua) showing a decreasing trend (Figure 1 and Table 1).

Figure 1. *Klebsiella pneumoniae*: Percentage of isolates nonsusceptible to carbapenems (imipenem or meropenem) between 2014 and 2016

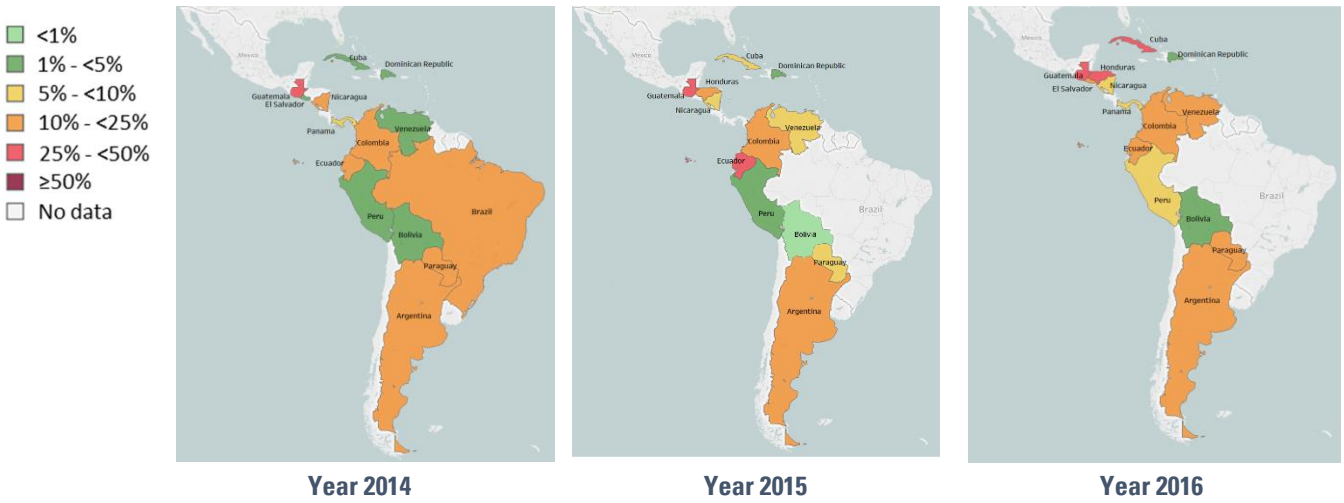

Table 1. *Klebsiella pneumoniae*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to carbapenems (imipenem or meropenem) including 95% confidence intervals (95% CIs)

	2014			2015			2016				
Country	**N**	**% I+R**	**(95% CI)**	**N**	**% I+R**	**(95% CI)**	**N**	**% I+R**	**(95% CI)**	**Trend**	
Argentina	1,554	15	(13-17)	1,732	11	(9.6-13)	2,103	17	(15-19)	p=0.016	↗
Bolivia	559	2	(0.8-3.1)	660	0	(0-0.6)	1,280	1	(0.6-1.7)		
Brazil	611	18	(15-21)								
Colombia	6,779	12	(11-13)	10,059	15	(14-16)	10,006	16	(15-17)	p<0.0001	↗
Cuba	119	2	(0.6-6.4)	76	5	(1.9-12)	31	32	(18-50)	p<0.0001	↗
Dominican Republic	119	2	(0.6-6.4)	134	2	(0.6-6)	274	1	(0.3-3)		
Ecuador	2,199	20	(18-22)	1,581	34	(32-36)	1,382	24	(22-26)	p<0.0001	↗
El Salvador	66	3	(0.8-10)				441	20	(17-24)		
Guatemala	1,013	29	(26-32)	1,156	36	(33-39)	1,266	29	(27-32)		
Honduras				3,413	15	(14-16)	15,459	32	(31-33)		
Nicaragua	270	22	(17-27)	2,075	8	(6.9-9.2)	197	7	(4.2-11)	p<0.0001	↘
Panama	1,825	8	(6.8-9.3)				3,151	6	(5.2-6.9)		
Paraguay	940	12	(10-14)	1,519	9	(7.7-11)	836	18	(16-21)	p<0.001	↗
Peru	400	1	(0-2)	572	1	(0.5-2.2)	937	8	(6.4-9.9)	p<0.0001	↗
Venezuela	773	3	(2.0-4.5)	928	9	(7.3-11)	2,749	14	(13-15)	p<0.0001	↗

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

Escherichia coli

Escherichia coli is a Gram-negative enterobacterium commonly found in the digestive tract of humans, and it frequently causes infections in humans *(6)*. It can lead to both community intestinal infections (diarrheal symptoms or intra-abdominal infections such as cholecystitis and cholangitis) and extraintestinal infections (complicated or uncomplicated urinary tract infections), as well as nosocomial infections (e.g., catheter-related bacteremia, urinary infection associated with bladder catheterization). In pediatric populations, it is a frequent cause of sepsis and neonatal meningitis. The main problem posed by *Escherichia coli* is the development of antibiotic resistance. Depending on the region, the percentage of extended-spectrum-β-lactamase (ESBL)-producing strains can reach up to 30% *(7, 8)*. In addition to ESBL, the presence of carbapenemase-producing strains globally has also made treatment more difficult *(9)*. As a result, *Escherichia coli* is on the WHO global priority list for research and development of new antibiotics *(10)*.

Trends in AMR

In 2016, 12 countries submitted data regarding the susceptibility to the third-generation cephalosporins. The nonsusceptibility percentage to the third-generation cephalosporins ranged from 21% (715/3,406) in Argentina to 60% (299/499) in Dominican Republic (Figure 2 and Table 2). At present, carbapenems seem to be still effective in the region. Of the 13 reporting countries, the percentage non-susceptible was below 7% in 12 countries, of which percentage in 6 countries (Argentina, Bolivia, Dominican Republic, El Salvador, Nicaragua and Panama) was below 1%. Honduras has shown relatively higher nonsusceptibility compared to other countries in the region. The percent non-susceptible was 21% and 26% in 2015 and 2016 respectively. Bolivia and Brazil have shown significant increasing nonsusceptibility trends over the past three years (Figure 3 and Table 3).

Figure 2. *Escherichia coli*: Percentage of isolates nonsusceptible to third-generation cephalosporins (ceftazidime or cefotaxime) between 2014 and 2016

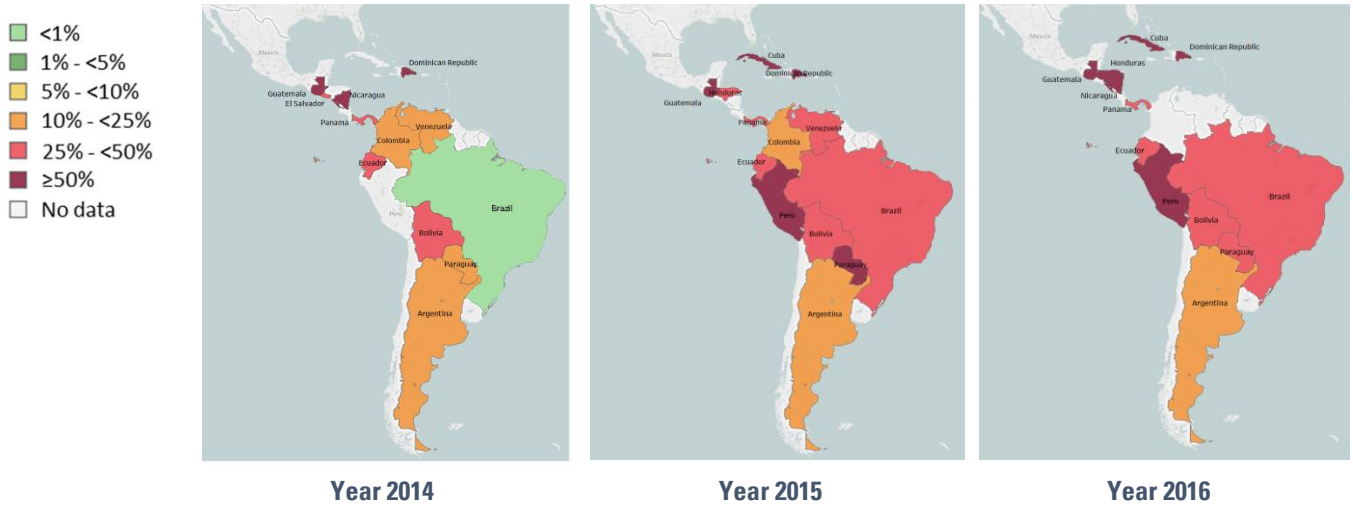

Table 2. *Escherichia coli*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to third-generation cephalosporins (ceftazidime or cefotaxime) including 95% confidence intervals (95% CIs)

Country	2014			2015			2016			Trend	
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)		
Argentina	617	17	(14-20)	3,623	19	(18-20)	3,406	21	(20-22)	p=0.003	↗
Bolivia	2,494	36	(34-38)	1,942	48	(46-50)	2,525	38	(36-40)		
Brazil	456	0	(0-0.8)	1,911	38	(36-40)	1,368	33	(31-36)	p<0.0001	↗
Colombia	21,216	15	(15-15)	30,362	14	(14-14)					
Cuba				98	56	(46-65)	8	75	(41-93)		
Dominican Republic	357	60	(55-65)	500	56	(52-60)	499	60	(56-64)		
Ecuador	3,976	42	(40-44)	2,751	46	(44-48)	3,840	38	(36-40)	P<0.001	↘
El Salvador	1,696	41	(39-43)								
Guatemala	902	65	(62-68)	1,873	56	(54-58)	1,999	51	(49-53)	p<0.0001	↘
Honduras				3,780	48	(46-50)	6,239	54	(53-55)		
Nicaragua	415	65	(60-69)				394	59	(54-64)		
Panama	2,518	26	(24-28)	3,702	28	(27-29)	7,436	26	(25-27)		
Paraguay	757	21	(18-24)	2,122	56	(54-58)	526	30	(26-34)	p<0.0001	↗
Peru				2,072	50	(48-52)	3,006	59	(57-61)		
Venezuela	4,500	14	(13-15)	6,657	25	(24-26)					

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

Figure 3. *Escherichia coli*: Percentage of isolates nonsusceptible to carbapenems (imipenem or meropenem) between 2014 and 2016

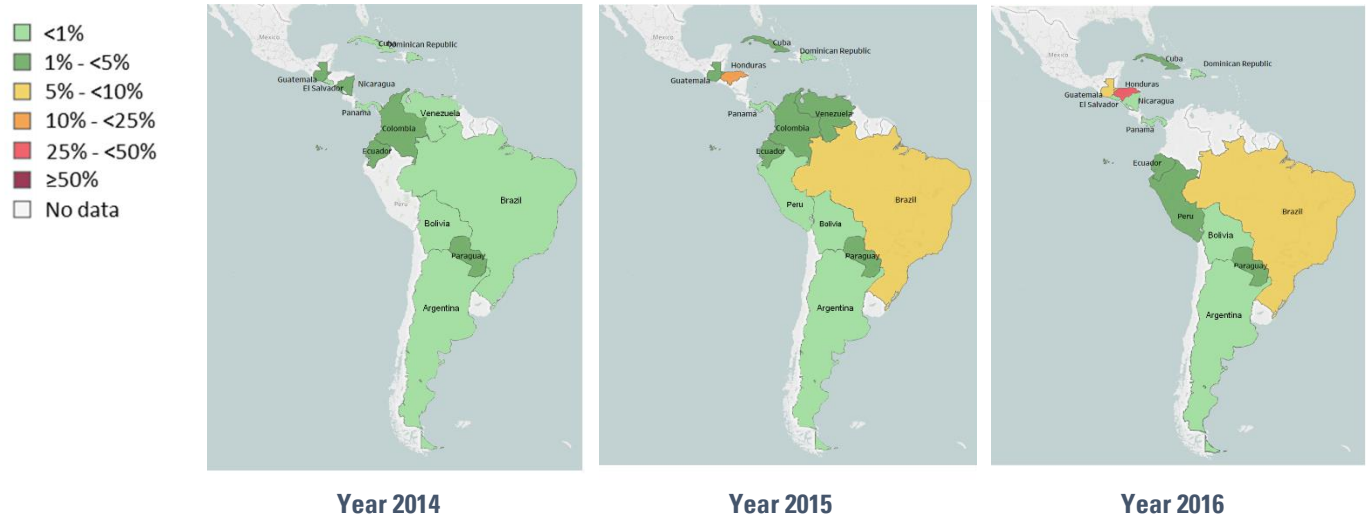

Table 3. *Escherichia coli*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to carbapenems (imipenem or meropenem) including 95% confidence intervals (95% CIs)

Country	2014			2015			2016			Trend
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)	
Argentina	2,053	0.6	(0.4-1)	3,582	0.6	(0.4-0.9)	3,552	0.6	(0.4-0.9)	
Bolivia	2,494	0	(0-0.15)	1,773	0	(0-0.2)	5,210	0.4	(0.3-0.6)	p<0.0001 ↗
Brazil	598	0.6	(0.2-1.6)	1,860	9.5	(8.2-11)	1,309	6.3	(5.1-7.7)	p<0.001 ↗
Colombia	10,016	1.2	(1.0-1.4)	15,218	3.7	(3.4-4)				
Cuba	54	0	(0-6.6)	98	4.1	(1.6-10)	36	2.8	(0.5-14)	
Dominican Republic	357	0	(0-1.1)	500	0	(0-0.8)	499	0.4	(0.1-1.4)	
Ecuador	4,450	1.2	(0.9-1.6)	3,375	1.8	(1.4-2.3)	3,775	1.2	(0.9-1.6)	
El Salvador	8,500	0	(0-0.05)				782	0.4	(0.1-1.1)	
Guatemala	944	4.7	(3.5-6.2)	1,843	3.9	(3.1-4.9)	1,971	5.4	(0.5-6.5)	
Honduras				3,471	21.0	(20-22)	7,329	26	(25-27)	
Nicaragua	420	2.2	(1.2-4.1)				658	0.9	(0.4-2)	
Panama	2,531	0.4	(0.2-0.7)	3,701	0.2	(0.1-0.4)	7,429	0.3	(0.2-0.5)	
Paraguay	729	2	(1.2-3.3)	1,997	1.3	(0.9-1.9)	497	1.2	(0.6-2.6)	
Peru				2,007	0.6	(0.3-1)	3,106	2.2	(1.7-2.8)	
Venezuela	3,541	0.3	(0.2-0.5)	2,460	1.2	(0.8-1.7)				

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

Acinetobacter baumannii

Acinetobacter species are ubiquitous in nature and generally do not cause infections in healthy populations *(11)*. Since they can survive for months on inert surfaces, hospital surfaces become their main reservoirs, and the hands of hospital staff members are the main transmission vectors *(5)*. *Acinetobacter* infections mainly occur in patients admitted to critical units who are undergoing broad-spectrum antibiotic treatments. They also occur in environments with high colonization pressure and commonly present as ventilator-associated pneumonia or catheter-related bacteremia *(11)*. A high frequency of carbapenem-resistant *Acinetobacter baumannii* has been observed due to the presence of different carbapenemases. In addition, high frequencies of infections caused by extremely resistant strains have made the second-line antibiotic treatment less effective and more toxic. Since *Acinetobacter baumannii* is probably the most difficult multi-resistant bacterium to treat, prevention of health care-associated infections (HAIs) is critical *(12)*. *Acinetobacter* spp. infections in critical units are associated with high mortality *(13)*.

Trends in AMR

In 2016, a total of 17,700 isolates were reported by 15 countries. The percentage of nonsusceptibility to carbapenems ranged from 29% (2,415/8,327) in Honduras to 89% in Peru (525/590) and Guatemala (407/457). Overall, countries in the region have shown high resistance to carbapenems, with 10 countries having nonsusceptibility levels above 50%. Four countries (Bolivia, the Dominican Republic, Peru, and Venezuela) showed significant increasing nonsusceptibility trends between 2014 and 2016, while six countries (Argentina, Brazil, Colombia, Ecuador, Panama, and Paraguay) exhibited decreasing trends (Figure 4 and Table 4).

Figure 4. *Acinetobacter baumannii*: Percentage of isolates nonsusceptible to carbapenems (imipenem or meropenem) between 2014 and 2016

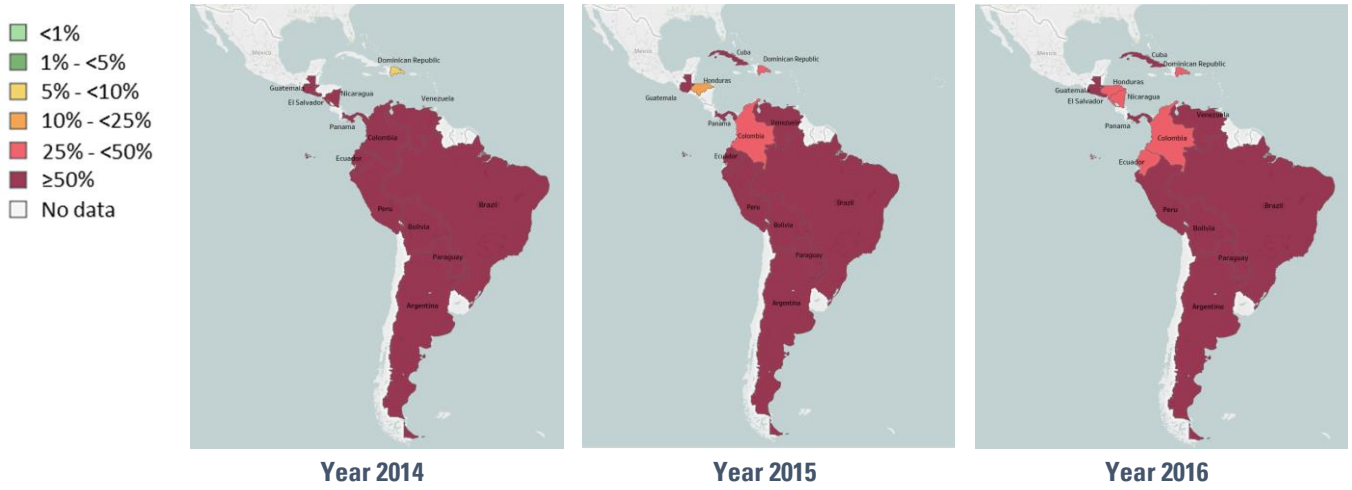

Table 4. *Acinetobacter baumannii*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to carbapenems (imipenem or meropenem) including 95% confidence intervals (95% CIs)

Country	2014			2015			2016			Trend	
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)		
Argentina	1,649	87	(85-89)	1,643	85	(83-87)	1,504	85	(83-87)	p=0.047	↘
Bolivia	374	69	(64-73)	483	75	(71-79)	733	78	(75-81)	p<0.001	↗
Brazil	1,209	89	(87-91)	2,610	91	(90-92)	1,266	85	(83-87)	p<0.001	↘
Colombia	1,235	50	(47-53)	1,547	49	(47-51)	1,064	46	(43-49)	p=0.028	↘
Cuba				28	82	(64-92)	9	89	(57-98)		
Dominican Republic	36	8	(2.7-21)	50	38	(26-52)	108	41	(32-50)	p<0.001	↗
Ecuador	372	63	(58-68)	296	64	(58-69)	212	45	(38-52)	p<0.0001	↘
El Salvador	1,852	56	(54-58)				563	72	(68-76)		
Guatemala	912	88	(86-90)	1,013	85	(83-87)	457	89	(86-92)		
Honduras				1,124	23	(21-26)	8,327	29	(28-30)		
Nicaragua	354	69	(64-74)				232	47	(41-53)		
Panama	1,505	71	(69-73)	1,211	61	(58-64)	1,469	59	(56-61)	p<0.0001	↘
Paraguay	788	81	(78-84)	439	66	(61-70)	102	70	(61-78)	p<0.0001	↘
Peru	161	81	(74-86)	599	86	(83-89)	590	89	(86-91)	p<0.01	↗
Venezuela	165	62	(54-69)	303	69	(64-74)	1,064	73	(70-76)	p<0.01	↗

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a Gram-positive bacterium that frequently causes HAIs and poses significant treatment problems due to its development of resistance to different antibiotics. *Staphylococcus aureus* can colonize skin and nasal passages and even the digestive tract in certain population groups such as diabetic, hemodialysis, institutionalized, and immunosuppressed patients and intravenous drug users *(14, 15)*. The most common community-associated infections are skin and soft tissue infections and osteoarticular, bacteremia, and endocarditis infections *(16)*. It can also produce HAIs including catheter-associated urinary tract infection, prosthetic device infections (osteoarticular, cardiovascular, neurosurgical), and nosocomial pneumonia. Approximately one third of patients with staphylococcal bacteremia develop local complications or septic embolisms at a distance, and overall mortality is between 20% and 40% *(17)*. The development of methicillin resistance (MRSA) has hindered antibiotic treatment and worsened the prognosis of bacteremia, increasing mortality and readmissions resulting from complications in comparison with bacteremia due to sensitive *Staphylococcus aureus* (MSSA) *(18, 19)*. It has been shown that universal decolonization of patients with MRSA in intensive care units significantly reduces all HAIs, including MRSA infections *(20)*, and that presurgical decolonization reduces post-surgical infections in prosthetic surgery *(21, 22)*.

Trends in AMR

In 2016, 15 countries reported antimicrobial susceptibility results from 36,828 nosocomial *Staphylococcus aureus* isolates to ReLAVRA, of which 44% (n=16,280) were identified as MRSA isolates. More than half (n=8) of these countries reported MRSA percentages higher than 50%. Three countries (Bolivia, Ecuador, and Paraguay) showed

significant increases in MRSA percentages between 2014 and 2016, while five countries (Argentina, Brazil, Colombia, Guatemala, and Panama) exhibited decreasing trends over that period (Figure 5 and Table 5).

Figure 5. *Staphylococcus aureus*: Percentage of isolates nonsusceptible to oxacillin or cefoxitin between 2014 and 2016

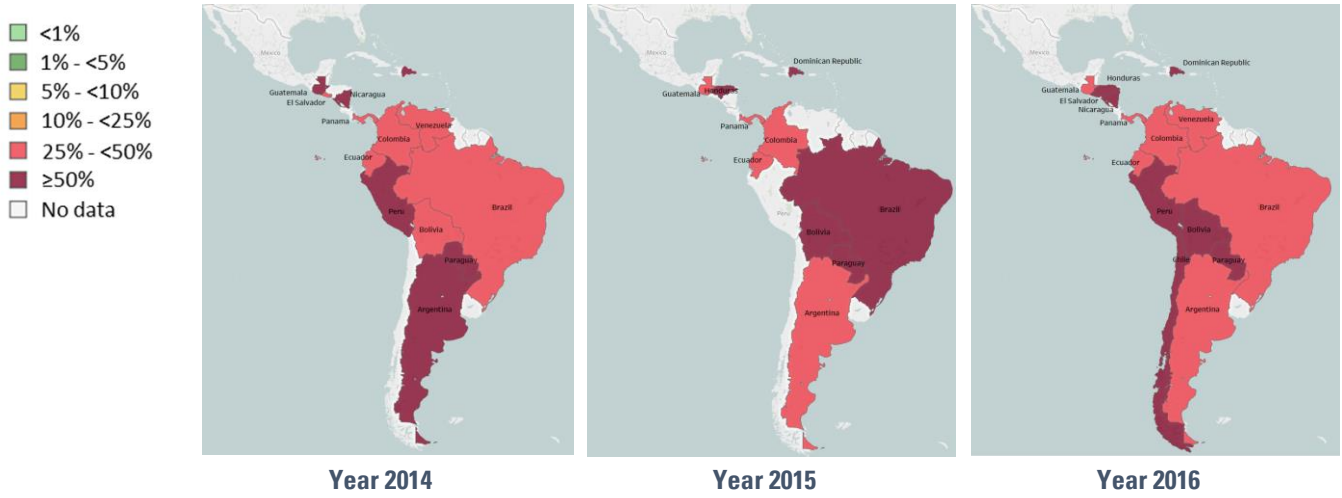

Table 5. *Staphylococcus aureus*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to oxacillin or cefoxitin including 95% confidence intervals (95% CIs)

Country	2014			2015			2016			Trend	
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)		
Argentina	1,561	50	(48-52)	1,545	44	(44-46)	1,625	47	(45-49)	p=0.048	↘
Bolivia	615	46	(42-50)	878	53	(50-56)	1,342	57	(54-60)	p<0.0001	↗
Brazil	1,231	43	(40-46)	445	52	(47-57)	1,135	33	(30-36)	p<0.0001	↘
Chile							379	98	(96-99)		
Colombia	9,196	36	(35-37)	12,676	35	(34-36)	10,035	34	(31-37)	p<0.01	↘
Dominican Republic	61	54	(42-66)	106	56	(47-65)	207	62	(55-68)		
Ecuador	1,243	43	(40-46)	878	45	(42-48)	1,503	48	(45-51)	p<0.01	↗
El Salvador	3,045	47	(45-49)				577	54	(50-58)		
Guatemala	745	68	(65-71)	863	48	(45-51)	1,030	43	(40-46)	p<0.0001	↘
Honduras				3,528	50	(48-52)	5,837	52	(51-53)		
Nicaragua	151	72	(64-79)				159	58	(50-65)		
Panama	1,870	37	(35-39)	1,890	34	(32-36)	2,688	26	(24-28)	p<0.0001	↘
Paraguay	1,171	58	(55-61)	658	66	(62-70)	1,082	68	(65-71)	p<0.0001	↗
Peru	245	77	(72-82)				447	67	(63-71)		
Venezuela	860	35	(32-38)				8,782	47	(46-48)		

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis. Data on susceptibility to oxacillin are listed if data on susceptibility to cefoxitin were not available.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is a Gram-negative bacterium that primarily causes hospital-acquired infections. It can produce a wide variety of clinical conditions including catheter-related bacteremia, ventilator-associated pneumonia, and urinary tract infections associated with bladder catheterization in patients in critical units; post-surgical infections associated with prosthetic devices in neurosurgical patients; and skin and soft tissue infections in patients with burns. In intensive care units, mortality from bacteremia due to *Pseudomonas aeruginosa* is around 20% to 39% *(23-26)*. In ventilator-associated pneumonia, mortality can reach up to 44% *(27)*. *Pseudomonas aeruginosa* has intrinsic resistance against different antibiotics due to the presence of inducible chromosomal β-lactamases and constitutive or inducible efflux pumps. It also has the ability to develop resistance to virtually all available antibiotics through selection of mutations in chromosomal genes *(28, 29)*. The likelihood of resistance development during antibiotic treatment increases in infections with high inoculum and infections located in tissues that are difficult for antibiotics to access. This is why high doses of combination antibiotic therapy are necessary. *Pseudomonas aeruginosa* can survive on surfaces for months. Humid areas such as drains and siphons are the main environmental reservoirs in hospitals *(30)*.

Trends in AMR

In 2016, a total of 38,512 isolates were reported by 14 countries to ReLAVRA. The percentage of nonsusceptibility to carbapenems ranged from 20% (31/154) in the Dominican Republic to 69% (827/1,198) in Peru. Between 2014 and 2016, four countries (Bolivia, Brazil, Paraguay, and Peru) exhibited significant increasing nonsusceptibility trends, while three countries (Argentina, Guatemala, and Panama) showed decreasing trends (Figure 6 and Table 6).

Figure 6. *Pseudomonas aeruginosa*: Percentage of isolates nonsusceptible to carbapenems (imipenem or meropenem) between 2014 and 2016

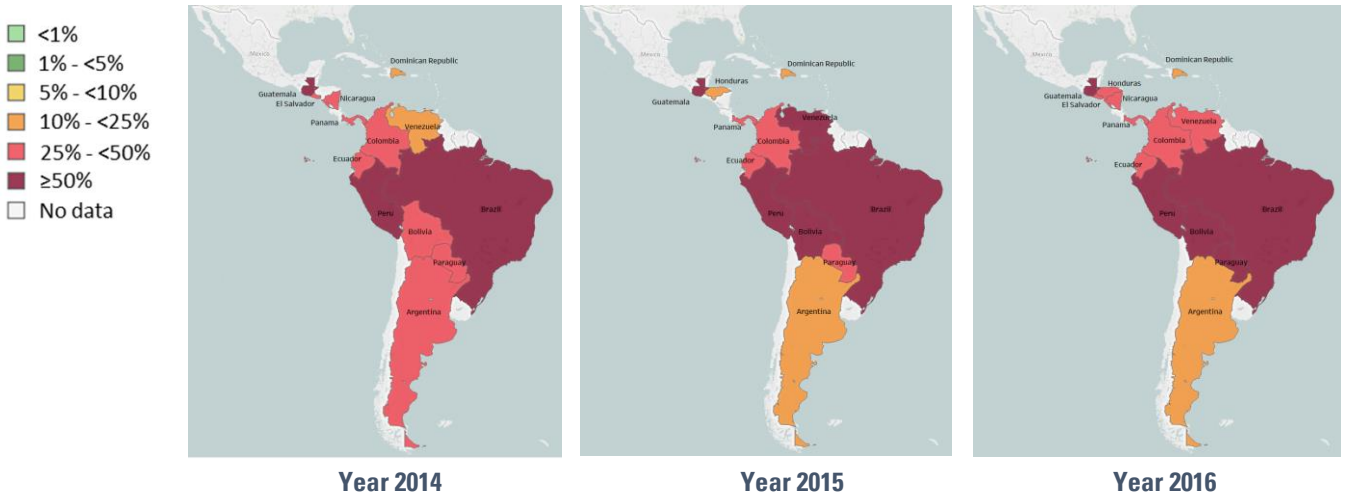

Table 6. *Pseudomonas aeruginosa:* Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to carbapenems (imipenem or meropenem) including 95% confidence intervals (95% CIs)

Country	2014			2015			2016				
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)	Trend	
Argentina	3,967	48	(46-50)	4,207	18	(17-19)	4,028	22	(21-23)	p<0.0001	↘
Bolivia	354	45	(40-50)	745	61	(57-64)	920	59	(56-62)	p<0.001	↗
Brazil	1,434	52	(49-55)	2,199	62	(60-64)	1,554	56	(54-58)	p=0.02	↗
Colombia	4,658	27	(26-28)	7,032	28	(27-29)	6,463	26	25-27)		
Dominican Republic	91	21	(14-30)	86	24	(16-34)	154	20	(14-27)		
Ecuador	1,023	32	(29-35)	797	34	(31-37)	825	31	(28-34)		
El Salvador	1,971	30	(28-32)				522	43	(39-47)		
Guatemala	1,119	71	(68-74)	877	54	(51-57)	1,003	55	(52-58)	p<0.0001	↘
Honduras				1,849	17	(15-19)	11,635	35	(34-36)		
Nicaragua	244	40	(34-46)				177	28	(22-35)		
Panama	1,601	40	(38-42)	1,847	36	(34-38)	2,446	36	(34-38)	p<0.01	↘
Paraguay	948	38	(35-41)	1,273	40	(37-43)	651	53	(49-57)	p<0.0001	↗
Peru	414	62	(57-67)	546	69	(65-73)	1,198	69	(66-72)	p=0.001	↗
Venezuela	916	21	(18-24)	2,316	74	(72-76)	6,936	46	(45-47)		

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

Neisseria gonorrhoeae

Neisseria gonorrhoeae is a Gram-negative intracellular coccobacillus that causes infections only in humans. It infects genital tracts and other mucous membranes, such as the oropharynx, conjunctiva, and rectum, in both females and males *(31)*. It is one of the most frequent causes of sexually transmitted diseases and represents a global public health problem. WHO estimated that there were a million new chlamydia, *Neisseria gonorrhoeae*, trichomoniasis, and syphilis infections every day globally in 2016 *(32)*. *Neisseria gonorrhoeae* has shown resistance not only to ceftriaxone and cefixime (the most commonly used antibiotics for treatment) but also to quinolones, macrolides, and tetracycline *(33)*.

Trends in AMR

Data regarding *Neisseria gonorrhoeae* susceptibility are relatively limited in the region in comparison with other pathogens. In 2016, a total of 2,990 isolates were reported to ReLAVRA. Argentina and Chile reported data for three consecutive years. Both of these countries showed increasing temporal trends in nonsusceptibility (Figure 7 and Table 7).

Figure 7. *Neisseria gonorrhoeae*: Percentage of isolates nonsusceptible to fluoroquinolone (ciprofloxacin) between 2014 and 2016

Table 7. *Neisseria gonorrhoeae*: Total number of isolates tested (N) and percentage of isolates nonsusceptible (% I+R) to fluoroquinolone (ciprofloxacin) including 95% confidence intervals (95% CIs)

Country	2014			2015			2016			Trend	
	N	% I+R	(95% CI)	N	% I+R	(95% CI)	N	% I+R	(95% CI)		
Argentina	679	62	(58-66)	728	67	(64-70)	709	71	(0.68-0.74)	p<0.001	↗
Bolivia	5	40	(12-77)								
Brazil							550	56	(52-60)		
Chile	1,184	56	(53-59)	1,500	63	(61-65)	1,599	67	(65-69)	p<0.0001	↗
Colombia	83	55	(44-65)	98	54	(44-64)	96	63	(53-72)		
Cuba				38	53	(38-68)					
Dominican Republic	32	72	(55-85)	132	79	(71-85)					
El Salvador	20	100	(84-100)				12	100	(76-100)		
Panama	20	0	(0-16)	21	10	(2.9-30)					
Paraguay	39	75	(60-86)	35	86	(71-94)	24	71	(51-85)		
Peru				8	100	(68-100)					
Venezuela				4	100	(51-100)					

The symbols ↗ and ↘ indicate significant increases and decreases in the percentage of nonsusceptible isolates, respectively, between 2014 and 2016. Only countries that reported 30 isolates or more per year for three consecutive years were included in the trend analysis.

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