**Point prevalence survey of antibiotic use in hospitals in Latin American countries**

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**Background:** Point prevalence surveys (PPSs) on antibiotic use are useful for understanding different aspects related to prescription patterns in hospitals.

**Methods:** An adaptation of the WHO methodology for a PPS on antibiotic use was applied. Hospital wards were divided into medical (MED), surgical (SUR), ICUs, gynaecology and obstetrics (GO), high-risk (HR) and mixed wards (MIX). A web application (RedCap\(^*\)) through a mobile device was used for data collection.

**Results:** Between December 2018 and August 2019, 5444 patients in 33 hospitals in five countries were included (10 hospitals in Cuba, 7 in Paraguay, 6 in El Salvador, 5 in Mexico and 5 in Peru). Of these patients, 54.6% received at least one antibiotic, with variations between and within hospitals and countries. Antibiotics were more frequently used in ICUs (67.2%), SUR (64.5%) and MIX wards (54.2%), with 51.2% of antibiotics prescribed for community-acquired infections (CAIs), 22.9% for healthcare-associated infections (HAIs), 11.1% for surgical prophylaxis and 6.1% for unknown reasons. Adherence to guidelines was observed in 68.6% of cases (72.8% for CAIs, 72.4% for HAIs and 44.3% for prophylaxis). Third-generation cephalosporins were the class of antibiotics most frequently used (26.8%), followed by carbapenems (10.3%) and fluoroquinolones (8%). Targeted treatments were achieved in 17.3% of cases.

**Conclusions:** Antibiotic use was generally higher than that published in other studies. There is an urgent need to promote and strengthen the antimicrobial stewardship programmes in Latin America.

**Introduction**

Antimicrobial resistance (AMR) is a worldwide phenomenon that has worsened in recent decades, linked to the increased use and abuse of antimicrobials, which have spread not only in human and veterinary medicine, but also to other fields such as agriculture and the environment.\(^3\)

Countries in the Americas began the implementation of National Action Plans in line with the WHO Global Action Plan on Antimicrobial Resistance launched in 2015.\(^2\) A key action is to optimize the use of antimicrobials in human and animal health, addressing the need to implement antimicrobial stewardship programmes (ASPs) both in hospitals and primary care settings.

Surveillance systems of antimicrobial consumption and AMR provide essential data for implementing ASPs. Continuous data collection on antibiotic prescribing is not easy due to the high workload and level of resources needed.\(^3\) A viable alternative is to collect data at a specific point in time, which can be done by using the point prevalence survey (PPS) methodology. This type of survey permits (i) the measurement of antimicrobial use along time, assessing changes in prescribing trends; (ii) the identification of...
targets for quality improvement in different hospital wards; and (iii) the evaluation of the effectiveness of interventions implemented in response to indicators identified during previous surveys. PPSs have been used in global and regional studies in the Caribbean and Europe, as well as in country-level studies in China, Saudi Arabia, the USA and Viet Nam, among others.

Antimicrobial consumption studies in hospitals from countries in Latin America are scarce. A recently published scoping review on ASPS in Latin America showed that although utilization of antimicrobials was the most frequently reported outcome, most studies had been done by measuring DDDs and only a few through a PPS. During recent years, multicountry studies, such as the Global-PPS of antimicrobial consumption, which included 4122 patients from 21 hospitals in Argentina, Chile, Costa Rica and Brazil, and a PPS on healthcare-associated infections (HAIs) and antimicrobial consumption including 2740 patients from 11 hospitals from four Latin American countries—Brazil, Colombia, Mexico and Venezuela—were conducted.

The present Latin American PPS (Latin-PPS) began with an initial pilot phase conducted between November 2017 and February 2018, including 12 hospitals from four countries: Costa Rica (4), Peru (3), Chile (2) and Nicaragua (2) (unpublished data). After this pilot phase, some improvements, mostly related to data collection and analysis, were introduced.

This article presents results of the Latin-PPS carried out after the pilot phase in 33 Latin American hospitals from five countries (Cuba, El Salvador, Mexico, Paraguay and Peru) as a baseline survey to implement or strengthen existing ASPs.

Methods

The Latin-PPS included minor adaptations of the WHO methodology for a PPS on antibiotic use in hospitals. As in the WHO protocol, only antibiotics were considered (see below). Main differences were the exclusion of the McCabe score, and differences in the criteria to assess compliance with clinical practice guidelines (CPGs). All variables collected are shown in Appendix 1, available as Supplementary data at JAC Online. The following is a summary of the main methodological aspects.

Hospital selection

A sample of hospitals was selected by the Ministries of Health (MoHs) in agreement with the Latin-PPS coordination team and designated partners (such as universities) according to some predefined criteria (e.g. hospital size, regional distribution, feasibility, human resources potentially involved and needs and interest in implementing or strengthening an ASP in the near future).

Patient selection

All patients hospitalized according to the daily census in the ward at 8:00 a.m. on the day of the study were included in the survey, regardless of whether they were receiving antibiotics or not. Day-case patients (e.g. those undergoing same-day treatment or surgery and discharge; outpatient departments, emergency room or outpatient dialysis) were excluded.

Survey procedures

All beds in each ward (e.g. general surgery) were surveyed in a single day, and each ward was studied only once during the period. Prior to starting the study, hospital coordinators were asked to submit the schedule listing which wards would be surveyed each day and the number of researchers to be deployed. This aimed to assess the feasibility of conducting the study in an organized way. Data collection for the entire hospital was completed within a maximum of three consecutive weeks from the first day of data collection.

Hospital wards were divided into medical (MED), surgical (SUR), ICUs (including medical, surgical, paediatric and neonatal units), gynaecology and obstetrics (GO), high-risk (HR; haematology, oncology, burns, transplantation and infectious diseases) and mixed (MIX) wards. The latter consisted of units where patients were admitted without differentiation between medical and surgical diseases.

Contents of the survey

The survey was divided into two sections. The first one (patient information) needed to be completed for all admitted patients, and included the type of ward, demographics, date of admission, catheterizations, intubation and surgery during the current admission. The second part (indication and antibiotic data) needed to be completed only for patients receiving oral or parenteral antibiotics on the day of the survey. Antibiotics previously prescribed during admission were excluded. All systemic antibiotics listed in the original WHO protocol (ATC codes J01) plus oral presentation of vancomycin (ATC A07A) and metronidazole (P01AB01) were available to be ticked in a dropdown list. Topical antibiotics and those used for the treatment of tuberculosis were excluded. The information requested in this section included the type of indication (treatment or prophylaxis), guidance for treatment (empiric or tailored to microbiological findings), diagnosis, microbiological results, antibiotics prescribed (drug, dose, interval, route of administration) and compliance with CPGs. A prescription was considered compliant if it was in line with local, national or international CPGs in use at the institution, as defined by the research team. When assessment of compliance was not possible (e.g. type of indication unknown or other than prophylaxis or treatment; diagnosis unknown or undefined), it was classified as not assessable.

Training

Virtual sessions were held for coordinators and investigators from each hospital. These included a practical revision of study variables and information technology aspects, followed by simulation exercises based on current real cases to adjust all proceedings.

Data collection and review

Data were directly uploaded to RedCap, a tool that includes a mobile app functionality that allows offline data collection on tablets and smartphones. Electronic forms were formatted to include multiple quality control checks to avoid wrong data entry.

Patient identities were known only by local researchers, and patient information was uploaded anonymously, through a previously assigned code for each unit and hospital. Throughout the study period, study coordinators reviewed all files between 24 and 72 h after being uploaded, allowing prompt detection of missing data (e.g. age, gender, date of admission, type of indication, diagnosis) and inconsistencies. This review made it possible to quickly hold discussions with the local coordinators, verify quality of data and use standardized and homogenized criteria, especially to determine adherence to CPGs. Finally, in less than 5% of the patients, some type of data (mainly type of indication or diagnosis) was not available for analysis. Data were safely stored in a server hosted by the Pan American Health Organization (PAHO).

Data analysis

The analysis was performed using the R software environment. Absolute frequencies and proportions are reported for qualitative variables. Means
and ranges are presented for continuous variables. Data from individual hospitals were aggregated to calculate all indicators.

As the present study was not conducted on a random sample of hospitals, no countrywide inference measures were calculated. Therefore, statistical tests were deemed not to be required, as the analysis was limited to the sample of hospitals included. At the hospital level, no inference was necessary as a daily inpatient census had been included during the study period.17,18

Ethics
The study was approved by the Ethics Committee for each hospital in Cuba, Mexico, Paraguay and Peru, as well as by the PAHO Ethics Review Committee. In the case of El Salvador, approval was provided by the National Committee for Ethics of Research in Health.

Results
The Latin-PPS was conducted between December 2018 and August 2019 and included 33 hospitals from five countries: Cuba (10 hospitals), Paraguay (7), El Salvador (6), Mexico (5) and Peru (5). A total of 5444 patients were surveyed, with a mean of 165 patients (range 22–469) per hospital, higher for El Salvador’s hospitals (mean 326.2 participants per hospital) and lower for Paraguay (mean 63.8). Eighteen (55%) hospitals had more than 200 beds, 10 (30%) between 100 and 200, and 5 (15.1%) had fewer than 100 beds. Thirty facilities belonged to the public sector (90.9%) and 24 were located in the capital city (72.7%). The average occupancy rate during the study period was 60%, except for Paraguay (48.7%). The main reason for this relatively low bed occupancy was that the study covered two vacation periods (December–February and July–August) with the consequent reduction in hospitalization. Regarding their complexity, 16 were tertiary hospitals (48.5%), 10 were secondary (30.3%), 6 were specialized (18.2%) and 1 was for primary care (3%). Mean age of participants was similar for all countries (42.7 years; range 0–102); 4376 (80.4%) of patients were ≥18 years old. Table 1 shows characteristics of hospitals and Table 2 the demographic information of patients included.

Fifty-four percent of patients received at least one antibiotic, with considerable variations between and within hospitals and countries (Table 3). Ten percent of treatments were administered orally (varying from 5.7% in Mexico to 12.9% in Cuba). The lowest antibiotic use was found in Cuban hospitals (47.6%) and the highest in the Paraguayan sample (81.1%). In general, ICUs had the highest prevalence of antibiotic use (67.2%), ranging from 44.5% in Peru to 83.9% in El Salvador. SUR wards (64.5%) had the second highest prevalence (ranging from 56.8% in Peru to 84.4% in Paraguay), followed by MED wards (54.2%) (ranging from 48.2% in Cuba to 79.3% in Paraguay). Antibiotic use in adult units was 52.1% and in paediatric units was 58.8%.

Overall, community-acquired infections (CAIs) were the most frequent reason for prescribing antibiotics (51.2%), followed by HAIs (22.9%), surgical prophylaxis (11.1%) and medical prophylaxis (4.0%). In 6.1% of the cases, the reason (e.g. CAI, HAI, prophylaxis) was not stated in the medical record; in 4.7% of cases, antibiotics were prescribed for other situations not related to treatment or prophylaxis, where antibiotics are typically not indicated.

Table 1. Characteristics of hospitals included in the Latin-PPS, 2018–19

| Characteristic                  | Cuba | Mexico | El Salvador | Peru | Paraguay | Total |
|--------------------------------|------|--------|-------------|------|----------|-------|
| Number of hospitals included   | 10   | 5      | 6           | 5    | 7        | 33    |
| Number of participants         | 1197 | 585    | 1957        | 1258 | 447      | 5444  |
| Average number of participants by hospital (range) | 119.7 (22–306) | 117 (31–213) | 326.2 (181–469) | 251.6 (97–391) | 63.8 (37–98) | 165.0 (22–469) |

Table 2. Demographics of patients included in the Latin-PPS, 2018–19

| Demographic | Cuba | Mexico | El Salvador | Peru | Paraguay | Total |
|-------------|------|--------|-------------|------|----------|-------|
| Mean age (years) | 46.7 | 36.7 | 44.4 | 41.9 | 34.4 | 42.7 |
| Age categories, years, n (%) | | | | | | |
| <1          | 62 (5.2) | 72 (12.3) | 148 (7.6) | 162 (12.9) | 62 (13.9) | 506 (9.3) |
| 1–4         | 60 (5.0) | 25 (4.3) | 60 (3.1) | 36 (2.9) | 31 (6.9) | 212 (3.9) |
| 5–17        | 73 (6.1) | 67 (11.5) | 111 (5.7) | 54 (4.3) | 45 (10.1) | 350 (6.4) |
| 18–65       | 634 (52.9) | 317 (54.2) | 1126 (57.5) | 695 (55.2) | 230 (51.5) | 3002 (55.2) |
| >65         | 368 (30.7) | 104 (17.8) | 512 (26.2) | 311 (24.7) | 79 (17.7) | 1374 (25.2) |
| Gender      | | | | | | |
| Male        | 576 (48.1) | 321 (54.9) | 953 (48.7) | 570 (45.3) | 238 (53.2) | 2658 (48.8) |
| Female      | 621 (51.9) | 264 (45.1) | 998 (51.0) | 686 (54.5) | 207 (46.3) | 2776 (51.0) |
| Transgender | 0 (0) | 0 (0) | 2 (0.10) | 1 (0.08) | 1 (0.2) | 4 (0.07) |
| Unknown     | 0 (0) | 0 (0) | 4 (0.20) | 1 (0.08) | 1 (0.2) | 6 (0.11) |
Table 3. Prevalence of antibiotic use by country and type of ward in the Latin-PPS, 2018–19

| Country       | Cuba          | Mexico       | El Salvador   | Peru          | Paraguay      | Total         |
|---------------|---------------|--------------|---------------|---------------|---------------|---------------|
|               | Admitted, n   | Antibiotic use, n (%) | Admitted, n   | Antibiotic use, n (%) | Admitted, n | Antibiotic use, n (%) | Admitted, n   | Antibiotic use, n (%) | Admitted, n   | Antibiotic use, n (%) | Admitted, n   | Antibiotic use, n (%) |
| Prevalence of antibiotic usea | 1197 | 570 (47.6) | 584b | 359 (61.5) | 1957 | 1076 (55) | 1258 | 604 (48.0) | 446b | 362 (81.1) | 5442b | 2971 (54.6) |
| Prevalence of antibiotic use by ward type | | | | | | | | | | | | |
| MED           | 556 | 268 (48.2) | 250 | 145 (58.0) | 1182 | 626 (53.0) | 767 | 392 (51.1) | 242 | 192 (79.3) | 2997 | 1623 (54.2) |
| SUR           | 193 | 123 (63.7) | 214 | 146 (68.2) | 330 | 211 (63.9) | 220 | 125 (56.8) | 64 | 54 (84.4) | 1021 | 659 (64.5) |
| ICU           | 96 | 68 (70.8) | 64 | 42 (65.6) | 93 | 78 (83.9) | 92 | 41 (44.5) | 33 | 25 (75.7) | 378 | 254 (67.2) |
| GO            | 148 | 46 (31.1) | 31 | 11 (35.5) | 166 | 82 (49.4) | 109 | 29 (26.6) | 107 | 91 (85.0) | 561 | 259 (46.2) |
| HR            | 152 | 52 (34.2) | 25 | 15 (60.0) | 158 | 61 (38.6) | 17 | 1 (5.8) | 0 | 0 (0) | 352 | 129 (36.6) |
| MIX           | 52 | 13 (25) | 0 | 0 (0) | 28 | 18 (64.3) | 53 | 16 (5.8) | 0 | 0 (0) | 133 | 47 (35.3) |

aNumber of patients who received at least one antibiotic out of the total number of hospitalized patients.
bOne registry in Mexico and one in Paraguay were missing one type of ward variable.
cAdult, paediatric and neonatal ICUs.

Table 4. Distribution of antibiotic use by type of indication in the Latin-PPS, 2018–19

| Indication Type | Cuba n (%) | Mexico n (%) | El Salvador n (%) | Peru n (%) | Paraguay n (%) | Total n (%) |
|----------------|------------|--------------|-------------------|------------|---------------|-------------|
| HAI            | 119 (20.3) | 98 (26.5)   | 283 (25.3)        | 165 (26.5) | 35 (9.5)      | 700 (22.9)  |
| CAI            | 334 (56.9) | 152 (41.1)  | 527 (47.3)        | 356 (57.2) | 197 (53.7)    | 1566 (51.2) |
| Medical prophylaxis | 17 (2.9) | 9 (2.4)     | 41 (3.8)          | 15 (2.4)  | 41 (11.2)      | 123 (4.0)   |
| Surgical prophylaxis | 77 (13.0) | 43 (11.6)  | 110 (10.0)        | 45 (7.2)   | 64 (17.4)      | 339 (11.1)  |
| Otherb         | 5 (0.9)    | 38 (10.3)   | 67 (6.1)          | 15 (2.4)   | 18 (4.9)       | 143 (4.7)   |
| Unknownc       | 35 (6.0)   | 30 (8.1)    | 84 (7.5)          | 27 (4.3)   | 12 (3.3)       | 188 (6.1)   |
| Total number of indications | 587 | 370         | 1112              | 623        | 367           | 3059        |

bNumber of this specific type of indication (e.g. HAI, CAI, surgical prophylaxis) out of the total number of indications. Each patient could have up to three indications, so that the total number of indications exceeds the number of patients surveyed in each country indicated in Table 3.
cOther includes situations not related to treatment or prophylaxis, where antibiotics are typically not indicated (e.g. tumours or cancer, trauma, closed fractures, stroke or vascular neurological sequelae, cirrhosis, gastro intestinal bleeding, cholelithiasis, nephrolithiasis, lung bullae, dialysis, uncomplicated pancreatitis, pancytopenia, uninfected diabetic foot, deep vein thrombosis, morbid obesity, pneumothorax, non-specific pleural effusion, uncomplicated postpartum period).
cType of indication (e.g. HAI, CAI or prophylaxis) unknown.
antibiotics most frequently prescribed for treating HAIs (Table S2). For surgical prophylaxis, first-generation cephalosporins accounted for 35.7% of all prescriptions, and 3GCs represented 29.1% of all antibiotics prescribed, reaching 52.9% in the sample from El Salvador (Table S3).

Overall, microbiological studies were requested in 44.3% prior to starting antibiotic treatment, with Cuban (19.6%) and Paraguayan (27.6%) hospitals showing the lowest figures. Targeted treatments were achieved in 17.3% of cases, being higher for Mexican hospitals (27.4%) (Table S4).

Discussion
The present Latin-PPS showed that more than half of hospitalized patients received an antibiotic on the day of the survey. Considering exclusively the use of antibiotics (excluding all other antimicrobials), the prevalence for the Latin American countries studied was higher than that reported in the Global-PPS in 2015, conducted only in adults (around 31%). The European PPS in 2016–17 (28%), the USA PPS in 2015 (46%), and the Saudi Arabia PPS (44%), but similar to that from China (56%) and lower than that from Viet Nam (67.4%). Even those European countries with higher use (e.g. Cyprus, Bulgaria, Italy, Malta and Spain) exhibited a prevalence of 40%–45%, lower than the figures found in the present study.

The prevalence of antibiotic use found in this research was similar to that reported in the previous Latin American study (50%), but higher than that found in Latin America at the Global-PPS (33.3%). Although the Latin-PPS included 5444 patients from 33 hospitals in five countries, compared with 4122 patients from 19 hospitals in four countries in the Global-PPS, sample size alone wouldn’t justify these differences. Instead, they might be due to the fact that other countries were included in the Global-PPS (Argentina, Brazil, Chile and Costa Rica), the characteristics of hospitals involved, and other factors such as the temporality of data collection. Therefore, comparisons among different PPS studies should be made with caution and considering contextual information.

The higher prevalence of use of antibiotics in ICUs is consistent with previous publications.
### Table 6. Compliance with guidelines for treatment and prophylaxis in the Latin-PPS, 2018–19

| Guideline compliance<sup>a</sup> | Cuba <sup>n</sup>/N (%) | Mexico <sup>n</sup>/N (%) | El Salvador <sup>n</sup>/N (%) | Peru <sup>n</sup>/N (%) | Paraguay <sup>n</sup>/N (%) | Total <sup>n</sup>/N (%) |
|------------------------------|-------------------------|---------------------------|-----------------------------|------------------------|-----------------------------|------------------------|
| Guideline compliance by indication type |                           |                           |                             |                        |                             |                        |
| HAI                          | 457/695 (65.7)          | 321/442 (72.6)            | 927/1332 (69.6)             | 622/873 (71.2)         | 291/474 (61.0)              | 2618/3816 (68.6)        |
| CAI                          | 108/161 (67.1)          | 126/145 (86.9)            | 295/420 (70.2)              | 188/267 (70.4)         | 42/56 (75)                  | 760/1049 (72.4)         |
| Antibiotic prophylaxis       |                         |                           |                             |                        |                             |                        |
| HAI                          | 108/161 (67.1)          | 126/145 (86.9)            | 295/420 (70.2)              | 188/267 (70.4)         | 42/56 (75)                  | 760/1049 (72.4)         |
| Guideline compliance by ward type |                           |                           |                             |                        |                             |                        |
| MED                          | 245/343 (71.4)          | 140/170 (82.3)            | 583/791 (73.7)              | 410/557 (73.6)         | 169/271 (47.6)              | 1547/2102 (73.6)        |
| SUR                          | 70/145 (48.3)           | 128/196 (65.3)            | 141/241 (58.5)              | 115/176 (65.3)         | 43/65 (66.1)                | 497/823 (60.4)          |
| ICUs                         | 53/94 (56.4)            | 29/45 (64.4)              | 56/102 (54.9)               | 52/79 (65.8)           | 25/40 (62.5)                | 215/360 (59.7)          |
| GO                           | 38/69 (55.1)            | 9/12 (75.0)               | 72/98 (73.5)                | 25/37 (67.5)           | 54/98 (55.1)                | 198/314 (63.0)          |
| HR                           | 41/59 (69.5)            | 15/19 (63.1)              | 61/78 (78.2)                | 1/1 (100)              | 0 (0)                       | 118/157 (75.1)          |
| MIX                          | 10/15 (66.7)            | 0 (0)                     | 14/22 (63.6)                | 19/23 (82.6)           | 0 (0)                       | 43/60 (71.6)            |

<sup>a</sup>Other and unknown indications (as described in Table 4) are excluded, due to the lack of reliability in establishing compliance with guidelines.

### Table 7. Antibiotics prescribed in the Latin-PPS, 2018–19

| Antibiotic group | Cuba <sup>n</sup>/N (%) | Mexico <sup>n</sup>/N (%) | El Salvador <sup>n</sup>/N (%) | Peru <sup>n</sup>/N (%) | Paraguay <sup>n</sup>/N (%) | Total <sup>n</sup>/N (%) |
|-----------------|--------------------------|---------------------------|-----------------------------|------------------------|-----------------------------|------------------------|
| J01DD 3GCs (ceftriaxone, cefotaxime, ceftazidime) | 223 (29.8) | 132 (24.9) | 468 (29.9) | 233 (24.8) | 95 (18.3) | 1151 (26.8) |
| J01DH Carbapenems (meropenem, imipenem, ertapenem) | 20 (2.7) | 80 (15.1) | 164 (10.5) | 159 (17.0) | 21 (4.1) | 444 (10.3) |
| J01MA Fluoroquinolones (ciprofloxacin, levofloxacin) | 52 (6.9) | 6 (0.3) | 10 (0.6) | 11 (1.2) | 1 (0.2) | 75 (1.7) |
| J01XD Imidazole derivatives (metronidazole) | 77 (10.3) | 92 (5.4) | 122 (7.3) | 56 (6.0) | 25 (4.8) | 290 (6.7) |
| J01XA Glycopeptide antibacterials (vancomycin) | 25 (3.3) | 10 (0.2) | 96 (6.1) | 94 (10.0) | 25 (4.8) | 290 (6.7) |
| J01GB Other aminoglycosides (amikacin, gentamicin) | 42 (5.6) | 3 (0.6) | 106 (6.8) | 59 (6.3) | 27 (5.2) | 271 (6.3) |
| J01FF Lincosamides (clindamycin) | 7 (0.9) | 1 (0.2) | 15 (0.9) | 11 (1.2) | 2 (0.4) | 31 (0.7) |
| J01CR Combinations of penicillins, including β-lactamase inhibitors (amoxicillin/sulbactam, piperacillin/tazobactam, ampicillin/sulbactam, amoxicillin/clavulanic acid) | 24 (3.2) | 19 (3.6) | 93 (5.9) | 21 (2.2) | 86 (1.9) | 243 (5.6) |
| J01CA Penicillins with extended spectrum (ampicillin, amoxicillin) | 5 (0.7) | 26 (4.9) | 96 (6.1) | 23 (2.5) | 62 (12.0) | 212 (4.9) |
| J01DB First-generation cephalosporins (cefazolin, cefotaxin, ertapenem) | 41 (5.5) | 21 (4.0) | 47 (3.0) | 39 (4.2) | 37 (7.3) | 187 (4.3) |
| J01DC Second-generation cephalosporins (cefoxime) | 106 (14.2) | 1 (0.2) | 0 (0) | 6 (0.6) | 0 (0) | 113 (2.6) |
| J01EE Combinations of sulphonamides and trimethoprim, including derivatives (trimethoprim/sulfamethoxazole) | 34 (4.5) | 9 (1.7) | 18 (1.1) | 25 (2.7) | 1 (0.2) | 87 (2.0) |
| J01FA Macrolides (azithromycin, clarithromycin) | 22 (2.9) | 3 (0.6) | 16 (1.0) | 19 (2.0) | 12 (2.3) | 72 (1.7) |
| J01DE Fourth-generation cephalosporins (cefepime) | 37 (4.9) | 13 (2.5) | 15 (1.0) | 3 (0.3) | 0 (0) | 68 (1.6) |
| J01DB First-generation cephalosporins (cefalexin) | 11 (1.5) | 3 (0.6) | 0 (0) | 4 (0.4) | 30 (5.8) | 48 (1.1) |
| J01A Tetracyclines (doxycycline) | 0 (0) | 7 (1.3) | 17 (1.1) | 4 (0.4) | 1 (0.2) | 29 (0.7) |
| J01CF β-Lactamase-resistant penicillins (oxacillin) | 0 (0) | 0 (0) | 12 (0.8) | 15 (1.6) | 2 (0.4) | 29 (0.7) |
| J01CE β-Lactamase-sensitive penicillins (penicillin) | 0 (0) | 0 (0) | 24 (1.5) | 0 (0) | 0 (0) | 24 (0.6) |
| J01X Polymyxins (colistin) | 0 (0) | 0 (0) | 14 (0.9) | 13 (1.4) | 0 (0) | 18 (0.4) |
| J01X Nitrofurans (nitrofurantoin) | 0 (0) | 0 (0) | 14 (0.9) | 13 (1.4) | 0 (0) | 18 (0.4) |
| Other antibiotics | 17 (2.3) | 14 (2.6) | 20 (1.3) | 20 (2.1) | 8 (1.5) | 79 (1.8) |

<sup>a</sup>Total number of antibiotics included in the study prescribed; some patients received more than one antibiotic for treatment of surgical prophylaxis.
In general, the prescription of 3GCs and carbapenems in this sample of hospitals from Latin America was higher than in most studies.\textsuperscript{5,7,10} Compared with the earlier study in Latin America,\textsuperscript{16} the use of 3GCs was also higher, but that of carbapenems was similar. The frequent use of 3GCs and carbapenems has also been reported from single-hospital studies in Peru\textsuperscript{19} and Mexico.\textsuperscript{20}

Regarding the treatment of HAIs, 3GCs represented 16% of antibiotics used, higher than in Central Europe (2%–10%),\textsuperscript{5,7} the USA (7%)\textsuperscript{5} and Asia (10%–13%),\textsuperscript{5} but lower than in Eastern Europe (20%).\textsuperscript{5} Similarly, carbapenems were prescribed in 21% of cases, comparable with the 18%–20% in Asia, but higher than in Europe (8%–16%, depending on the region)\textsuperscript{5,7} and the USA (7%).\textsuperscript{5}

Potential differences of resistance in Gram-negative bacilli could partly contribute to these prescription patterns. According to the SENTRY antimicrobial surveillance programme, the detection of an ESBL gene among non-carbapenem-resistant \textit{Escherichia coli} and \textit{Klebsiella pneumoniae} was 8.2% in Europe, 15.4% in Asia-Pacific and 30.3% in Latin America.\textsuperscript{21} In turn, limited available data suggest that the prevalence of carbapenem-resistant \textit{E. coli}, \textit{K. pneumoniae}, \textit{Acinetobacter baumannii} and \textit{Pseudomonas aeruginosa} might be similar across regions.\textsuperscript{22} Hence, the apparently higher prevalence of ESBLs may in part justify the increased use of some broader-spectrum antibiotics, such as carbapenems, and lower use of piperacillin/tazobactam in Latin America. Additionally, the low prescription of ampicillin/sulbactam, amoxicillin/clavulanate, amoxicillin/sulbactam, doxycycline and macrolides was probably also related to resistance patterns. However, other key drivers such as cultural habits and poor awareness, understanding and training on the AMR problem\textsuperscript{23} are likely to have a much greater influence on prescribing patterns.

Overall adherence to CPGs was found in about two-thirds of the cases, considerably better when antibiotics were prescribed for therapy than for prophylaxis. Specifically, regarding surgical prophylaxis, both the excessive use of ceftriaxone and the prolongation of surgery beyond 24 h have also been observed in several regions of the world.\textsuperscript{5} As described above, this assessment was initially done by the local team, and discussed with the study coordination team when needed. Adherence to guidelines of around 70% was similar in all countries, as well as constant and considerably lower adherence for prophylaxis.

Some criticisms have been published on the implementation of the WHO protocol,\textsuperscript{24} such as, for example, lack of information in medical records, misclassification of patients in relation to wards and type of infections (e.g. definition of HAIs) and a low acceptability of staff to perform the PPS. In our experience, the main challenges faced were related to the categorization of the type of indication (e.g. between \textit{Other} and \textit{Unknown}) and for the accuracy of the diagnosis (e.g. \textit{Undefined} or \textit{Unknown}). In both situations, this difficulty was associated with a lack of information in some cases, but mostly with the somewhat confusing definitions in the original protocol. These issues prompted several reviews both with hospital coordinators and for the final analysis of results. On the other hand, the strong support from hospital authorities to conduct the study, the careful selection of the research team by the hospital coordinators and their intensive training, and the collaboration of the attending physicians of each ward on the day of the survey considerably facilitated the development of the study.

The study has some limitations. Firstly, despite being the largest study performed in Latin America, it is still a sample of hospitals selected by the MoHS and universities, not representing the entire

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Percentage of antibiotic use according to the WHO AWaRe classification. (a) Percentage of overall use by country. (b) Percentage of antibiotic use according to the type of indication. SPs, surgical prophylaxis. This figure appears in colour in the online version of JAC and in black and white in the print version of JAC.}
\end{figure}
hospital population of every country. Secondly, comparisons with other studies is limited by several factors, such as the type and complexity of hospitals included, the methodology for the hospital selection, the sample size, the possible temporal variations in antibiotic use (e.g., due to changes in resistance patterns) and, probably more importantly, some differences in data collection methods and in the overall process for assessing the guidelines compliance.

Main strengths of this study are the largest (so far) number of countries and hospitals in the region and the data quality control. The latter was achieved through (i) intensive training of the hospital research teams; (ii) continuous communication and technical support; and (iii) permanent review of data inconsistencies during the survey period. Additionally, the adoption of a flexible data collection tool allowed the implementation of the survey even in facilities with human resource and IT constraints.

Conclusions
This study shows that there are key elements that should be addressed as a priority by MoHs, professional associations and regional organizations promoting ASPs. It is essential to develop and/or strengthen these programmes considering both a diagnostic approach (including a PPS if feasible) and attitudinal aspects related to antimicrobial prescribing. Emphasis should be placed on the implications for AMR of inappropriate prescribing, the need to improve compliance with CPGs, especially for surgical prophylaxis, and on establishing antibiotic selection criteria according to each indication (e.g. avoiding 3GCs as the initial choice for CAIs and surgical prophylaxis, reserving carbapenems to treat selected HAIs). It is also critical to increase microbiological diagnostics (e.g., by improving the access to diagnostic tools, increasing the submission of samples to the laboratory, and using the results to tailor the treatment). To achieve all these goals, it is necessary to ensure continuous and structured education for prescribers. In this regard, in November 2020, PAHO launched an e-learning training course for the ‘Implementation and Strengthening of Antimicrobial Stewardship Programs’, which is currently active at the time of this publication.

After completing the PPS, and under the umbrella of MoHs, first steps to implement an ASP (e.g., a baseline evaluation of human resources involved and previous activities related to antimicrobial stewardship initiatives, conformation of ASP teams, and sharing of PPS results with prescribers) began in many participating hospitals. Shortly afterwards, the COVID-19 pandemic struck, leading to serious difficulties in continuing with the progress of the programmes, due to the scarcity of human and material resources, and the redistribution of the tasks of most of the actors involved. At the time of publication of this study, as assessed in meetings with many of the participating hospitals, many of them have been progressively resuming ASP activities.

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Antibiotic use in Latin American hospitals

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Transparency declarations
None to declare.

Supplementary data
Tables S1 to S4 and Appendix 1 are available as Supplementary data at JAC Online.

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