Survey of antibiotic use at a tertiary care hospital in Mexico

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Abstract

Objective. To analyze antibiotic use in a tertiary care hospital in Mexico. **Materials and methods.** We conducted two point prevalence surveys based on the World Health Organization methodology in a tertiary care hospital in Guadalajara, Mexico. We surveyed the clinical records of patients with active antibiotic prescriptions (APs) in medical (MED), surgical (SUR), medical-surgical (MIX) wards, and intensive care units (ICUs). Descriptive statistics were estimated using Stata software. **Results.** We analyzed 929 APs from 403 patients. The prevalence of antibiotic use in the hospital was 47.5%. Antibiotics were more used in ICUs (59.5%) and MIX wards (54.8%). The main reasons for antibiotic use were community-acquired infections (45.2%), and preoperative prophylaxis (23.1%), mostly multidose and prolonged (89.3%). APs were mainly empirical (92.4%), administered parenterally (95.9%) and lacked subsequent review (30.3%). Bacterial culture testing was limited (30.5%). The most used antibiotics were ceftriaxone (18.9%), clindamycin (8.5%), and meropenem (8.2%). Most APs corresponded to Access (56.4%) and Watch antibiotics (35.6%) (AWaRe, WHO). **Conclusions.** We revealed frequent prescribing patterns of broad-spectrum antibiotics and differences in their use possibly related to patients' clinical profiles.

Keywords: point prevalence survey; antibiotic use; tertiary care; Mexican hospital

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Resumen

Objetivo. Analizar el uso de los antibióticos en un hospital de atención terciaria en México. **Material y métodos.** Se realizaron dos encuestas de prevalencia puntual, basadas en la metodología de la Organización Mundial de la Salud (OMS), en un hospital de atención terciaria en Guadalajara, México. Se encuestaron los expedientes clínicos de pacientes con prescripciones antibióticas activas (PAs) en salas médicas (MED), quirúrgicas (SUR), médico-quirúrgicas (MIX) y unidades de cuidados intensivos (UCIs). Se estimaron estadísticas descriptivas en el software Stata. **Resultados.** Se analizaron 929 PAs de 403 pacientes. La prevalencia hospitalaria del uso de antibióticos fue 47.5%. Los antibióticos se usaron más en UCIs (59.5%) y salas MIX (54.8%). Los principales motivos del uso de antibióticos fueron las infecciones adquiridas en la comunidad (45.2%) y las profilaxis preoperatorias (23.1%), mayormente multidosis y prolongadas (89.3%). Las PAs fueron principalmente empíricas (92.4%), parenterales (95.9%) y sin revisiones posteriores (30.3%). La realización de pruebas de cultivo de bacterias fue limitada (30.5%). Los antibióticos más usados fueron ceftriaxona (18.9%), clindamicina (8.5%) y meropenem (8.2%). La mayoría de PAs correspondieron a antibióticos Acceso (56.4%) y Vigilancia (35.6%) (AWaRe, OMS). **Conclusión.** Se revelaron patrones de prescripción frecuente de antibióticos de amplio-espectro y diferencias en su uso posiblemente relacionadas con los perfiles clínicos de los pacientes.

Palabras clave: encuestas de prevalencia puntual; uso de antibióticos; atención terciaria; hospital mexicano

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Antibiotics are crucial for effectively treating many hospitalized patients, but up to half of antibiotic prescriptions (APs) may be inappropriate or suboptimal.[1] The overuse and misuse of antibiotics increase selective pressure on bacteria, driving the development of various antimicrobial resistance (AMR) mechanisms.[2] AMR significantly reduces the clinical efficacy of available preventive and curative options for bacterial infections.[3] The use of certain antibiotic classes in hospital settings, such as broad-spectrum cephalosporins, fluoroquinolones, and carbapenems is associated with the development of multidrug-resistant organisms (MROs).[4] Recently, the World Health Organization (WHO) reported an alarming rate of AMR in pathogens responsible for hospital-associated infections such as *Klebsiella pneumoniae* and *Acinetobacter spp*.[5] Infections caused by MROs lead to higher mortality, longer hospital stays, and increased healthcare costs compared to those caused by susceptible bacteria.[6] Treating infections caused by MROs demands the use of broader-spectrum and last-resort antibiotics, creating a vicious cycle of antibiotic prescribing and AMR.[7] Implementing antimicrobial stewardship programs (ASPs) in hospitals is crucial for promoting the judicious use of antibiotics and improving clinical outcomes for patients.[8] However, impact assessments of ASPs typically focus on measuring antibiotic consumption at the hospital level rather than on what is specifically prescribed to patients.[9,10] A standardized and well-established method for antibiotic use surveillance at the patient level is based on point prevalence surveys (PPS).[11] The PPS have provided a comprehensive picture of the prevalence and patterns of antibiotic prescribing to patients in hospitals around the world, including Europe,[12] the USA,[13] the Caribbean,[14] Latin America,[15,16] and Mexico.[17] PPS data are indispensable for hospitals without ASPs and essential for identifying specific antibiotic use optimization targets in institutions that do have these programs.[11] Continuous targeting of antibiotic stewardship interventions is a cornerstone of ASPs to ensure the safety and efficacy of antibiotic therapies and minimize the risk of MROs emergence in the local healthcare setting.[18] In this study, we analyzed antibiotic use at a tertiary care hospital in Mexico using PPS.

Materials and methods

Study protocol

The study followed the WHO methodology for PPS on antibiotic use in hospitals (WPPS).[11] Data on antibiotics for systemic use according to the Anatomical Therapeutic Chemical (ATC) classification system (ATC code: J01) were collected. Topical and antituberculosis antibiotics were excluded.

Hospital surveyed

The study was conducted at Hospital in Guadalajara (HG), Mexico –a tertiary-level university hospital complex with 914 census beds. Thirty-nine wards/units were identified as available in the HG according to the hospital censuses reviewed during the surveys. HG provides healthcare to individuals from Jalisco and other areas of western Mexico who lack social security or access to public health services.

PPS questionnaires

We utilized three REDCap questionnaires with control checks to minimize the risk of data entry errors. These questionnaires have been previously employed in other tertiary-level hospitals in Mexico.[17]

We collected data on the general and infrastructural characteristics of the hospital and across its wards with medical (MED), surgical (SUR), mixed medical-surgical (MIX) services, and intensive care units (ICUs). The MIX wards accommodated patients both requiring or recovering from surgery, as well as those needing medical care for a range of surgical and non-surgical conditions.

We collected anonymous data on patients with active APs, in the beds of the wards/units providing the above services, such as date of admission, age, gender, clinical diagnoses, infection types (hospital-associated infection or community-acquired infection), and prophylaxis indications (medical prophylaxis or preoperative prophylaxis). We recorded the APs characteristics including generic antibiotic names, doses, intervals, route of administration, documented reviews (at 48 hours), duration of treatments, and its basis (empirical or targeted by bacterial culture test findings).

Survey of capabilities to optimize antibiotic use

The infrastructure, policies and practices, and monitoring and feedback activities available to antibiotic prescribers were investigated through an online survey, based on indicators proposed by a multinational panel of antimicrobial stewardship experts.[19] The HG authorities completed this survey.

Survey team and training

Three principal investigators, supported by medical and nursing staff from the HG who participated as

observers, conducted the PPS. The observers attended virtual training sessions on PPS methodology, practical handling of REDCap questionnaires, and procedures for clinical record review and data collection.

Survey dates

Two PPS were conducted: one in the last week of November 2023 and the second week of May 2024.

Patient selection

Using the daily hospital census, we identified hospitalized patients, up to 8:00 a.m. After reviewing its medical indication sheets, we distinguished patients with active APs (selected patients) from those not receiving antibiotics (admitted patients).

The patients hospitalized after 8:00 a.m., underwent surgeries on the day of the surveys, received outpatient care, or were in emergency rooms, were excluded.

Data collection and analysis

PPS data were captured directly on electronic tablets. The principal investigators supervised the clinical record review and data entry procedures in real-time.

The data from both PPS were consolidated and analyzed using Stata software. Absolute frequencies and proportions of qualitative variables were calculated, as well as means and ranges for continuous variables. The prevalence of antibiotic use by hospital and wards/units was expressed as percentages, calculated by dividing the number of selected patients by the number of admitted patients during the surveys.

The categorization of antibiotics into Access, Watch, and Reserve (AWaRe) groups was based on the WHO classification database for evaluating and monitoring antibiotic use.[20]

Results

Capabilities for optimizing antibiotic use

The HG has implemented an ASP since 2016, featuring information technology capabilities and a multidisciplinary team of healthcare professionals, including pharmacists and a physician leader.

Reported ASP activities include:

- Developing clinical practice guidelines for treating common infections.
- Requiring prescribers to document the indication for antibiotic use in clinical records.
- Implementing pre-dispensing antibiotic authorizations.
- Conducting post-review procedures for antibiotic therapies.
- Producing annual reports of hospital antibiotic consumption.

The HG also reports that it does not regularly audit the selection and duration of preoperative prophylaxis, nor does it offer additional salary support to ASP members.

Characteristics of selected patients

Four hundred and three patients with active APs were selected from 849 patients admitted. These patients were spread across 34 specialty wards, including internal medicine, infectious diseases, oncology, gastroenterology, nephrology, gynecology and obstetrics, general surgery, neurosurgery, orthopedic/trauma surgery, thoracic/cardiovascular surgery, and ICUs. Of these wards/units, 20 were designated for adult patients, 10 for pediatric patients, three for both adult and pediatric patients, and one specialized in neonatal care.

Most patients were male (57.8%, *n*= 233) and adults (71.0%, *n*= 288), with a mean age of 40.2 years old. The average hospital stay was 13.3 days (table I). The most common clinical diagnoses were pneumonia or lower respiratory infections (16.0%, *n*= 75), skin or soft tissue infections (SSTIs) (8.5%, *n*= 40), gastrointestinal infections (7.4%, *n*= 35), and clinical sepsis (6.8%, *n*= 32). Other common reasons for antibiotic use were non-infectious diagnoses (14.7%, n= 69) and prophylactic indications, mainly for trauma/orthopedic surgeries (3.0%, *n*= 14) (table I).

Use of antibiotics

The hospital prevalence of antibiotic use was 47.5%. Among the wards/units, the highest prevalence of antibiotic use corresponded to ICUs (59.5%), followed by the MIX (54.8%), SUR (49.4%) and MED (43.4%) wards (table II).

The treatment of patients with community-acquired infections was the primary reason for antibiotic use in the hospital overall (45.2%, *n*= 182), MED wards (60.5%, *n*= 127), and ICUs (48.0%, *n*= 12). Preoperative prophylaxis was the second most frequent reason for antibiotic use in the hospital overall (23.1%, *n*= 93) and the most common reason in the SUR (57.9%, *n*= 48) and MIX (42.4%, *n*= 36) wards. Most of the preoperative prophylaxis consisted of multi-dose schemes lasting more than 24 hours (89.3%, *n*= 93). At the hospital level, the

Table I

Demographic and clinical characteristics of selected patients in the hospital and across its wards/units. Guadalajara, Mexico, 2023-2024

	Hospital	*MED*	*SUR*	*MIX*	*ICUs*
Number of selected patients*	403	210	83	85	25
Number of diagnosis/prophylactic indications‡	470	255	91	92	32
Average length of hospital stays (days)	13.3	11.6	15.1	15.1	15.4
Mean age (years)§	40.2	44.9	35.4	36.3	24.6
Sex	% *(n)*	% *(n)*	% *(n)*	% *(n)*	% *(n)*
Male	57.8 (233)	52.9 (111)	69.9 (58)	57.7 (49)	60 (15)
Female	42.2 (170)	47.1 (99)	30.1 (25)	42.3 (36)	40 (10)
Age categories	% *(n)*	% *(n)*	% *(n)*	% *(n)*	% *(n)*
Adults (≥18 years old)	71.0 (286)	74.8 (157)	72.3 (60)	72.4 (62)	28.0 (7)
Children (29 days to 17 years old)	22.6 (91)	18.1 (38)	27.7 (23)	25.9 (22)	32.0 (8)
Neonates (zero to 28 days)	6.4 (26)	7.1 (15)	-	1.2 (1)	40.0 (10)
Clinical diagnosis	% *(n)*	% *(n)*	% *(n)*	% *(n)*	% *(n)*
Pneumonia or lower respiratory infection	16.0 (75)	22.4 (57)	4.4 (4)	6.5 (6)	25.0 (8)
Skin or soft tissue infection	8.5 (40)	7.1 (18)	9.9 (9)	14.1 (13)	-
Gastrointestinal infection	7.4 (35)	9.0 (23)	3.3 (3)	9.8 (9)	-
Clinical sepsis	6.8 (32)	9.4 (24)	1.1 (1)	2.2 (2)	15.6 (5)
Lower urinary tract infection	4.0 (19)	5.9 (15)	3.3 (3)	-	3.1 (1)
Intra-abdominal sepsis	4.0 (19)	3.9 (10)	5.5 (5)	2.2 (2)	6.3 (2)
Upper urinary tract infection	2.8 (13)	3.9 (10)	1.1 (1)	2.2 (2)	-
Bacteriemia	2.6 (12)	0.4 (1)	3.3 (3)	5.4 (5)	9.4 (3)
Central nervous system infection	2.3 (11)	1.6 (4)	1.1 (1)	1.1 (1)	15.6 (5)
Septic arthritis, osteomyelitis	2.1 (10)	2.0 (5)	2.2 (2)	3.3 (3)	-
Obstetric or gynecological infection	1.7 (8)	2.0 (5)	-	2.2 (2)	3.1 (1)
Cardiovascular system infection	1.3 (6)	2.0 (5)	-	1.1 (1)	-
Lung abscess, including aspergilloma	1.1 (5)	0.8 (2)	-	3.3 (3)	-
Ear, nose, throat, larynx or mouth infection	1.1 (5)	1.2 (3)	1.1 (1)	1.1 (1)	-
Immunodeficiency virus infection	1.1 (5)	1.2 (3)	2.2 (2)	-	-
Febrile neutropenia	1.1 (5)	2 (5)	-	-	-
Fever of unknown origin	0.9 (4)	1.6 (4)	-	-	-
Surgical site infection	0.9 (4)	-	3.3 (3)	1.1 (1)	-
Genitourinary infection in men	0.6 (3)	0.8 (2)	-	1.1 (1)	-
Endophthalmitis or other eye infections	0.4 (2)	0.8 (2)	-	-	-
Sexually transmitted infection	0.4 (2)	0 (0)	-	1.1 (1)	3.1 (1)
Pulmonary tuberculosis	0.2 (1)	0.4 (1)	-	-	-
Hepatitis C	0.2 (1)	0.4 (1)	-	-	-
Prophylactic indications					
Trauma and orthopedics	7.0 (33)	1.2 (3)	20.9 (19)	10.9 (10)	3.1 (1)
Gynecology and obstetrics	4.3 (20)	4.3 (11)	4.4 (4)	4.3 (4)	3.1 (1)

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Digestive tract	3.0 (14)	1.6 (4)	3.3 (3)	6.5 (6)	3.1 (1)
Central nervous system	2.3 (11)	2.0 (5)	6.6 (6)	-	-
Thoracic	0.6 (3)	-	1.1 (1)	1.1 (1)	3.1 (1)
Respiratory tract	0.2 (1)	-	1.1 (1)	-	-
Ophthalmic	0.2 (1)	-	1.1 (1)	-	-
Skin and soft tissue	0.2 (1)	-	1.1 (1)	-	-
Non-infectious diagnosis	14.7 (69)	12.5 (32)	18.7 (17)	19.6 (18)	6.3 (2)

MED: medical wards; SUR: surgical wards; MIX: medical-surgical wards; ICUs: intensive care units.
* Selected patients: patients who were receiving at least one antibiotic.
‡ Patients may have more than one clinical diagnosis and/or prophylactic indication.
§ Includes all patients aged one year or older.

Table II

Prevalence of antibiotic use and characteristics of antibiotic prescriptions in the hospital and across its wards/units. Guadalajara, Mexico, 2023-2024

		Hospital	*MED*	*SUR*	*MIX*	*ICUs*
Antibiotic use (%)*		47.5	43.4	49.4	54.8	59.5
Number of selected patients (n)‡		403	210	83	85	25
Number of admitted patients (N)§		849	484	168	155	42
Number of antibiotic prescriptions (n)		929	442	208	202	77
Mean length of antibiotic therapies (days)#		5.3	5.4	5.1	5.7	5.1
Characteristics of antibiotic use		% *(n)*	% *(n)*	% *(n)*	% *(n)*	% *(n)*
Patients by type of infection or prophylactic indication	Hospital-associated infections	13.4 (54)	10.5 (22)	15.7 (13)	10.6 (9)	40.0 (10)
	Community-acquired infections	45.2 (182)	60.5 (127)	16.9 (14)	34.1 (29)	48.0 (12)
	Medical prophylaxis	18.3 (74)	25.2 (53)	9.6 (8)	12.9 (11)	8.0 (2)
	Preoperative prophylaxis	23.1 (93)	3.8 (8)	57.9 (48)	42.4 (36)	4.0 (1)
	Single dose of antibiotics	7.5 (7)	25 (2)	4.2 (2)	8.3 (3)	-
	Multiple doses of antibiotics, 1 day	3.2 (3)	12.5 (1)	2.1 (1)	2.8 (1)	-
	Multiple doses of antibiotics, >1 day	89.3 (83)	62.5 (5)	93.8 (45)	88.9 (32)	100 (1)
Number of antibiotics per patient	1	34.7 (140)	39.1 (82)	32.5 (27)	31.8 (27)	16.0 (4)
	2	31.3 (126)	31.9 (67)	27.7 (23)	35.3 (30)	24.0 (6)
	3 or more	34.0 (137)	29.1 (61)	39.8 (33)	32.9 (28)	60.0 (15)
Prescriptions by route of administration	Parenteral	95.9 (891)	93.9 (415)	97.1 (202)	98.0 (198)	98.7 (76)
	Oral	3.9 (36)	6.1 (27)	2.4 (5)	2.0 (4)	-
	Inhaled	0.2 (2)	-	0.5 (1)	-	1.3 (1)
Prescriptions by type of treatment	Empiric	92.4 (858)	95.9 (424)	89.9 (187)	86.6 (175)	93.5 (72)
	Target	7.6 (71)	4.1 (18)	10.1 (21)	13.4 (27)	6.5 (5)
Patients with microbiological studies	At least one microbial culture	30.5 (123)	29.5 (62)	26.5 (22)	31.8 (27)	48.0 (12)
	No microbial culture	69.5 (280)	70.5 (148)	73.5 (61)	68.2 (58)	52.0 (13)
Patients with documented prescription review (48h)	Documented review	30.3 (122)	28.6 (60)	30.1 (25)	31.8 (27)	40.0 (10)
	Non documented review	69.7 (281)	71.4 (150)	69.9 (58)	68.2 (58)	60.0 (15)

MED: medical wards; SUR: surgical wards; MIX: medical-surgical wards; ICUs: intensive care units.
* Antibiotic use: percentage of patients who were receiving at least one antibiotic over the total number of admitted patients.
‡ Selected patients: patients who were receiving at least one antibiotic.
§ Admitted patients: total number of hospitalized patients.
# Up to date of patient selection for surveys.

patients receiving antibiotics for medical prophylaxis and hospital-associated infections accounted for 18.3% (*n*= 74), and 13.4% (*n*= 54), respectively. The highest proportions of patients with hospital-associated infections were found in the ICUs (40.0%, *n*= 10) and MIX wards (15.7%, *n*= 13) (table II).

Characteristics of antibiotic prescriptions

In total, 929 APs involving 30 antibiotics (ATC 5), from 18 antibiotic classes (ATC 4) were analyzed. All clinical records had documented indications for antibiotic use. APs mean duration was 5.3 days. The patient proportions receiving one (34.7%, *n*= 140), two (31.3%, *n*= 126), or three or more antibiotics (34.0%, *n*= 137) were similar. Most patients receiving three or more antibiotics were in the SUR wards (39.8%, *n*= 33) and ICUs (60%, *n*= 15) (table II).

At the hospital level, the parenteral administration of antibiotics was predominant (95.9%, *n*= 891). Most APs were also based on empirical decisions (92.4%, *n*= 858), compared to those targeted by bacterial culture test findings (7.6%, *n*= 71). About three out of 10 patients had records of at least one bacterial culture test (30.5%, *n*= 123). Nearly half of the ICU patients had bacterial culture tests conducted (48.0%, *n*= 12). The proportion of patients with subsequent review of APs was limited (30.3%, *n*= 122) (table II).

Most prescribed antibiotics

Third-generation cephalosporins were the most used class of antibiotics in the hospital overall (21.5%, *n*= 200), as well as in the MED (24.9%, *n*= 110), MIX (21.3%, *n*= 43), and SUR (18.3%, *n*= 38) wards. Carbapenems were the second most frequently used antibiotic class in the hospital overall (12.8%, *n*= 119), and the main used antibiotics in the ICUs (15.6%, *n*= 12). Other frequently prescribed antibiotic classes were lincosamides (HG: 8.5%, *n*= 79; MIX: 14.4%, *n*= 29; SUR: 13.0%, *n*= 27) and first-generation cephalosporins (SUR: 13.9%, *n*= 29) (supplementary material S1).[21]

The most used antibiotics in the hospital overall were ceftriaxone (18.9%, *n*= 176), clindamycin (8.5%, *n*= 79), meropenem (8.2%, *n*= 76), and cefalotin and vancomycin (6.9%, *n*= 64, each). Ceftriaxone was also the most used antibiotic in the MED (21.5%, *n*= 95), SUR (15.9%, *n*= 33), and MIX wards (21.3%, *n*= 43). Meropenem was the most prescribed antibiotic in ICUs (14.3%, *n*= 11). Other frequently prescribed antibiotics were clindamycin (SUR: 13.0%, *n*= 27; MIX: 14.4%, *n*= 29), cefalotin (SUR: 13.0%, *n*= 27), and vancomycin (ICUs: 13.0%, *n*= 10) (supplementary material S2).[21]

Antibiotic use according to AWaRe classification (WHO)

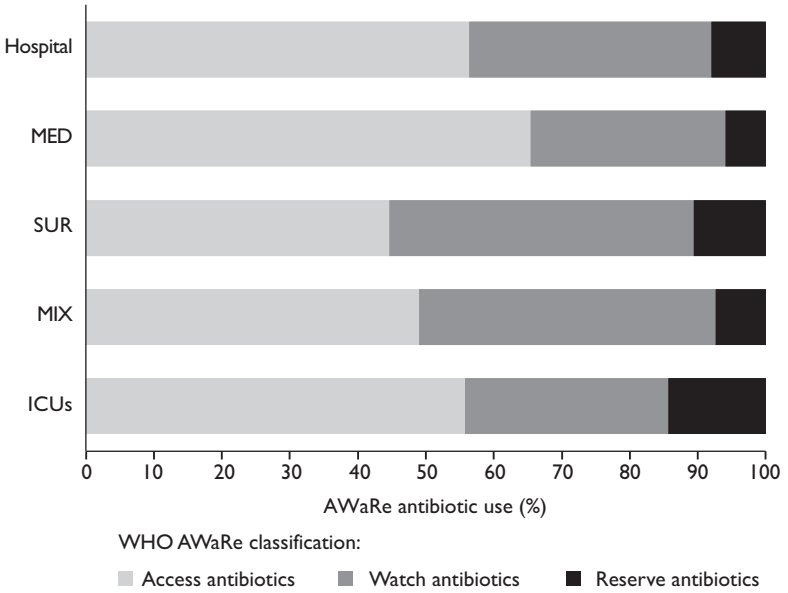
Eleven antibiotics from the Access AWaRe group (Access antibiotics) accounted for 56.4% (*n*= 524) of total APs. These antibiotics also had the highest use proportions in the MED (65.4%, *n*= 289), MIX (49.0%, *n*= 99) wards, and ICUs (55.8%, *n*= 43) . In the SUR wards, the use proportions of Access antibiotics, and antibiotics from the Watch AWaRe group (Watch antibiotics) were identical (44.7%, *n*= 93, both). The most used Access antibiotics in the hospital were clindamycin (8.5%, *n*= 79), cefalotin (6.9%, *n*= 64), and metronidazole (6.5%, *n*= 60) (figure 1, supplementary material S2).[21]

Fourteen Watch antibiotics accounted for 35.6% (*n*= 331) of total APs. Watch antibiotics were the second most prescribed agents in the MED (28.7%, *n*= 127), MIX (43.6%, *n*= 88) wards, and ICUs (29.9%, *n*= 23). The most used Watch antibiotics in the hospital were ceftriaxone (18.9%, *n*= 176), meropenem (8.2%, *n*= 76), and vancomycin (6.9%, *n*= 64) (figure 1, supplementary material S2).[21]

Five antibiotics from the Reserve AWaRe group (Reserve antibiotics) were used, accounting for 8.0% (*n*= 74) of total APs. The most prescribed Reserve antibiotics in the hospital were linezolid (3.7%, *n*= 34), tigecycline (2.0%, *n*= 19), and colistin (2.0%, *n*= 19). Linezolid was also the most used Reserve antibiotic in the wards / units (MED: 3.4%, *n*= 15; SUR: 3.4%, *n*= 15; MIX: 3.0%, *n*= 23; ICU: 6.5%, *n*= 5) (figure 1, supplementary material S2).[21]

Discussion

We conducted PPS in fourth largest hospital in Mexico and found that nearly half of the 849 admitted patients received antibiotics. The prevalence of antibiotic use in HG was higher compared to estimates from European hospitals (30.5%),[12] but lower than those from multiple hospitals in the USA (49.5%),[13] and Mexico, which ranged from 51.5% to 89.4%.[15-17] The use proportion of Access antibiotics was significantly higher than in other Mexican (≈25%) and Latin American (≈34%) hospitals, and nearly reached the WHO target (≥60%) for total antibiotic consumption in this AWaRe group.[20,22] In contrast, the use of Watch antibiotics was lower than the majority of hospital estimates included in a global PPS study across 69 countries.[22] Our findings partly reflect appropriate decisions in choosing Access antibiotics as the first choice for empiric treatment of common clinical infections. However, two of the three most prescribed agents, ceftriaxone and meropenem, were Watch antibiotics, associated with a higher relative risk of AMR and categorized as highest and high priority antibiotics for human medicine.[23]



MED: medical wards; SUR: surgical wards; MIX: medical-surgical wards; ICUs: intensive care units; WHO: World Health Organization; AWaRe: Access, Watch, and Reserve.

FIGURE 1. PERCENTAGE OF ANTIBIOTIC USE ACCORDING TO THE WHO AWARE CLASSIFICATION IN THE HOSPITAL AND ACROSS ITS WARDS/UNITS. GUADALAJARA, MEXICO, 2023-2024

More than 90% of total APs were empirical and administered parenterally. The high prevalence of empirical therapies is probably related to the scarce performance of bacterial culture tests. This poses a challenge for prescribers to confirm the identity of pathogens causing infections, assess the appropriateness of empirical treatments and recognize local AMR patterns. In turn, it also highlights an insufficient effort for the subsequent reviews of APs, even though this task is included in the ASP activities. The above, together with the frequent use of exclusively parenteral antibiotics, such as ceftriaxone, meropenem and cefalotin, likely contribute to the predominant use of the parenteral route. We cannot rule out the possibi-lity that some of the empirical and parenteral APs could have been de-escalated, switched to the oral route, or discontinued.

As observed in other PPS studies globally, including those from Latin America and Mexico, ICU patients receive antibiotics more frequently compared to those in other hospital wards.[15,17,24] The extensive use of antibiotics in ICUs is driven by various factors, including advanced age, immunosuppression, prolonged hospitalization, invasive medical procedures, and the severity of the patient diseases.[25] This was true for the ICU patients in this study, the majority of whom were afflicted by life-threatening conditions, including clinical sepsis, pneumonia, and central nervous system infections, frequently caused or complicated by bacterial pathogens. Even so, the antibiotic use in ICUs in this study was notably lower compared to estimates from other hospitals in Mexico (89.4%),[17] across Latin America (67.2%),[15] and from a global study of 1 265 ICUs in 75 countries (71%).[26]

Non-infectious diagnoses, SSTIs, and trauma/orthopedic surgeries were frequent reasons for APs, particularly in the MIX and SUR wards. Some APs for non-infectious causes may have been administered to patients with risk factors for hospital-associated infections such as comorbidities, prior colonization by opportunistic organisms, previous antibiotic use, urinary catheters, intrahospital transfers, and readmissions.[27] The use of antibiotics for SSTIs could partly be attributed to the increase in its incidence associated with the emergence of community-associated methicillin-resistant *Staphylococcus aureus*.[28] Similarly, the increased use for trauma and orthopedics could be linked to the growing burden of morbimortality from orthopedic injuries requiring surgical intervention, primarily due to falls, as the older population increases.[29] Both, SSTIs and prophylaxis of bone and joint infections are among the most common reasons for the use of Watch antibiotics in hospitals worldwide.[22,24] The

frequency of patients with these indications in the MIX and SUR wards may have contributed to the higher proportions of Watch antibiotic use, mainly third-generation cephalosporins. In these wards, also most patients received preoperative prophylaxis beyond the general recommendation of one dose before incision, often continuing for 24 hours or, exceptionally, up to 48 hours.[30] Given the average hospital stay on SUR and MIX wards, some of the multi-dose and prolonged preoperative prophylaxis courses could have been for patients with serious SSTIs requiring surgical debridement and drains, or severe trauma. However, compared with short courses of antibiotics, prolonged preoperative prophylaxis (>24 hours) does not provide additional protection against complications such as sepsis, multi-organ failure or death in critically injured patients, but does increase the risk of MRO infections.[31]

Our findings align with previous studies in Latin America and the Caribbean hospitals, indicating that third-generation cephalosporins are the most commonly used antibiotics.[15-17,32] Specifically, ceftriaxone is widely preferred globally for both prophylactic and therapeutic purposes,[22] likely due to its long half-life, tolerability, and efficacy against a broad range of infections.[33] However, up to one in three patients may receive inappropriate ceftriaxone therapies, often due to empirical use for suspected infections or as prophylactic purposes.[34] Furthermore, antimicrobial susceptibility testing (AST) results show that over 50% of *Escherichia coli* and *Klebsiella* spp strains in Mexican hospitals may be resistant to ceftriaxone.[35] While more research is necessary, a portion of the ceftriaxone prescriptions identified in this study may have been unnecessary or inappropriate.

This study has limitations inherent to the PPS methodology. The cross-sectional study design does not enable to identify day-to-day variability in antibiotic prescribing or determine the final duration of therapies. The clinical record data do not specify which antibiotics were prescribed for each clinical diagnosis.

In conclusion, our PPS reveal patterns of prescribing broad-spectrum antibiotics, particularly ceftriaxone, for empirical and parenteral therapies, as well as for multi-dose and prolonged preoperative prophylaxis. These findings highlight differences in antibiotic use across hospital wards/units, likely influenced by the clinical profiles of patients. PPS-based surveillance of antibiotic prescribing can help identify specific targets within hospitals, thereby guiding ASP interventions effectively.

Ethical approval

The protocol for this study was approved by the research ethics committee of the *Instituto Nacional de Salud Pública* of Mexico (CI 1533), and the research ethics committee of the *Hospital Civil de Guadalajara Fray Antonio Alcalde* (HCGFAA) (CEI 126/23). Informed consent was not required for the review of patient clinical records, as all data were anonymized, and no personal data or any other information that could subsequently identify the patients was collected. The authors are committed to protecting individuals' privacy and maintaining the confidentiality of collected data in accordance with the Declaration of Helsinki and the Regulations of the General Health Law on Health Research in Mexico.

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