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Original research

Point prevalence survey of antibiotics in a pediatric tertiary hospital in the Republic of Panama

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ABSTRACT

Objective. To conduct a point prevalence survey (PPS) of antibiotic use in the main pediatric tertiary-level hospital in Panama City to establish antibiotic prevalence and identify key areas for addressing antimicrobial resistance.

Methods. This point prevalence survey (PPS) conducted in a tertiary-level hospital in Panama followed the Pan American Health Organization's adaptation of the methodology proposed by the World Health Organization for PPSs on antibiotic use. Information obtained included patients' demographic characteristics, antimicrobial prescriptions, indication for antimicrobial use, and prescription's adherence to guidelines.

Results. Of 298 patients surveyed from August to September 2023, 176 (59.0%) were treated with antibiotics. The pediatric ward (86.3%) and the neonatal intensive unit (80.0%) had the highest prevalence of antibiotic use. Hospital-acquired infections accounted for 32.6% of antibiotic prescriptions, with piperacillin/tazobactam (29.4%), meropenem (15.3%), amikacin (15.3%), and ampicillin/sulbactam (10.2%) being the most prescribed. Treatment for community-acquired infections represented 55.9% of antibiotic prescriptions, with ampicillin (24.6%), gentamicin (22.6%), and ampicillin/sulbactam (14.0%) being the most frequently used. Of the prescriptions considered in the analysis, 61.0% adhered to hospital guidelines.

Conclusions. This PPS observed a high prevalence of antibiotic use. The findings suggest it is necessary to assess the need for ampicillin, gentamicin, and piperacillin-tazobactam use in patients admitted to pediatric critical care units, with special emphasis on children with pneumonia or sepsis diagnosis, the most common pathologies for which an antimicrobial was prescribed.

Keywords Drug resistance, microbial; antimicrobial stewardship; prevalence; pediatrics; Panama.

Antimicrobial resistance (AMR) is a global public health threat. Approximately 1.27 million deaths in 2019 were attributable to the misuse of antimicrobials in health care (1). AMR is a complex problem with many interrelated causes. Inappropriate use of antimicrobials and lack of surveillance systems are core contributors to the spread of AMR (2).

In response, the World Health Organization (WHO) has developed a Global Action Plan on Antimicrobial Resistance (3) to ensure the successful treatment and prevention of infectious diseases for as long as possible. Optimizing the use of antimicrobial agents is one of its five key strategic objectives. The latter is challenging, and selecting the right antibiotic may

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not be straightforward. Furthermore, information on antibiotic consumption and use is scarce in low- and middle-income countries (LMICs). Despite efforts by LMICs to report data on AMR, the low surveillance coverage reported by the Global Antimicrobial Resistance and Use System highlights the need for strengthening surveillance systems to provide accurate data that will inform effective policies to combat AMR (4).

Data on antibiotic use at the patient level is sparse due to the difficulties associated with the collection of prescribing data from fragmented sources. Hospitals are optimal settings for understanding antibiotic prescribing given the high burden of admitted patients who require antibiotic treatment. Collecting hospital data and subsequently implementing informed interventions to optimize antibiotic use in hospitals has potential to lower antibiotic resistance at local and higher levels. However, in most countries, continuous data collection on antibiotic prescribing is not possible due to the high workload and resources needed for regular monitoring. A viable alternative is to collect data at a specific point in time, which can be done successfully using the point prevalence survey (PPS) methodology. PPSs on antibiotic use have been conducted in hospitals around the world. Both the European Union and the United States have developed and carried out regional surveys using PPSs.

The WHO has created a similar PPS methodology to meet the needs and reflect the level of resources in LMICs while maintaining comparability with data collected in high-income countries (5). PPSs have been implemented globally and regionally in various LMICs, including in Latin America and the Caribbean (6, 7). The largest survey to date in Latin America was conducted in 33 hospitals in five countries through an adaptation of the WHO methodology for PPSs on antibiotic use (8).

Participation in a PPS can contribute to a hospital's antimicrobial stewardship program (ASP) activities in both high-income settings and in LMICs. By providing all participating hospitals with a personalized feedback report, the PPS allows local teams to identify targets for AMS without the need to invest time and resources in complex data analyses. Much can be gained by guiding hospitals to integrate PPS methodology throughout their ASPs and activities. Building on what already exists, supporting AMS broadly, and effectively communicating PPS results to prescribers, hospital management, and other health care workers can help secure their much-needed buy-in while empowering local champions to take the lead on the ASPs in their hospitals (7). This PPS study aimed to quantify antibiotic prevalence at a pediatric tertiary-level hospital in Panama City (Republic of Panama) and to identify key areas for AMS improvements.

METHODS

Study setting and participants

This cross-sectional survey was conducted at the Hospital del Niño Dr. José Renán Esquivel (HNDJRE), a 430-bed tertiary-level pediatric referral hospital in Panama City. This survey was part of the "Latin PPS" (2022-2023), a cohort using the Pan American Health Organization (PAHO) modified surveillance methodology for PPSs in Latin America. The Latin PPS consists of 67 hospitals in Latin America that completed an initial survey in 2019. Details on the Latin PPS methodology are available in the Appendix of the Latin PPS publication (8).

The internet-based survey included all inpatient wards at HNDJRE except the Emergency Department and one-day planned admissions (e.g., ambulatory surgery, hemodialysis, and similar), regardless of whether patients received antibiotics. The entire hospital was surveyed from 21 August to 8 September 2023.

Survey procedures

The Latin PPS for antibiotic use was a tool adapted by PAHO from the *WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals* (9). Other antimicrobials were excluded. The Latin PPS differs from the WHO protocol in that it excludes McCabe score and uses different criteria to assess compliance with clinical practice guidelines. All variables collected are available in the Appendix of the Latin PPS publication (8).

Hospital selection

The HNDJRE was selected by the Panama Ministry of Health in agreement with the Latin PPS coordination team according to predefined criteria (e.g., hospital size, regional distribution, feasibility, human resources potentially involved, and needs and interest in implementing or strengthening an ASP). All beds in each ward were surveyed in a single day, and each ward was studied only once during the period. Before starting the study, hospital coordinators had a schedule that included the date on which each ward would be surveyed and the surveyors responsible for the task. Data collection for the entire hospital was completed within 3 consecutive weeks of the first day of data collection. Hospital wards were divided into pediatrics, neonatology, intensive care (including neonatology and pediatrics), surgical, and high-risk (hematology, oncology, transplantation, and infectious diseases).

Survey contents

The survey was divided into two sections. The first section (patient information) had to be completed for all admitted patients and included the type of ward, the patient's demographic characteristics, date of admission, catheterizations, intubation, and surgery during the current admission.

The second part (indication and antibiotics data) was 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 protocol (Anatomical Therapeutic Chemical classification system [ATC] codes J01) plus the oral presentation of vancomycin (ATC AO7A) and metronidazole (ATC P01AB01) were available for selection from 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 clinical practice guidelines. A prescription was considered to be compliant if it aligned with the local, national, or international clinical practice guidelines used by the institution, as defined by the research team. When compliance assessment 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.

Survey preparation

Virtual sessions were held with the team of investigators. These included a practical revision of study variables and information technology aspects followed by simulation exercises based on current clinical cases to adjust all procedures. Data collection and review were directly uploaded to REDCap (REDCap Consortium), a tool that includes a mobile app with functionality that allows for 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 within 72 hours of being uploaded, allowing prompt detection of missing data (e.g., age, sex, date of admission, type of indication, and diagnosis) and inconsistencies. All data were safely stored in a server hosted by PAHO.

Data collection and management

Data were collected and uploaded using tablets and smartphones through the RedCap platform, which provided the functionality to collect this information offline. Usernames and passwords were assigned directly by PAHO coordinators, who also checked for missing information and data entry errors. The data gathered from the hospital included bed capacity, number of admissions per year, number of patients eligible for the survey, microbiology sample capacity, availability of laboratory equipment, infection control policies, and antimicrobial programs in place, if any. The data gathered from the hospital wards included the number of patients on the day of the survey and the specialty of the ward.

The data gathered for each patient included the reason for the antibiotic, the risk factors of receiving it, the antibiotic received, and details of the microbiology laboratory that confirmed the diagnosis. The data gathered on the antibiotics included its International Nonproprietary Name and the prescribed dose; if a prophylaxis, it was documented as PQ in the type of indication variable. Data collection occurred on Monday through Friday during 3 consecutive weeks.

Statistical analysis

The analysis was performed using a method that combines Visual Basic for Applications (VBA) with Microsoft Excel. Custom macros were developed in VBA to automate the generation of spreadsheets in Excel, thus facilitating data analysis and visualization. The process also included the use of datasets from REDCap. This seamless integration of VBA, Excel, and REDCap allowed for efficient and accurate data processing, producing detailed and rigorous data analyses. Absolute frequencies and proportions were reported for qualitative variables, and means for continuous variables.

Ethical approval

Patient information was anonymized during data collection, uploading, and analysis using anonymous identifiers. Because there was no direct contact with patients, informed consent was waived. However, the principal investigator obtained study approval from the HNDJRE ethics committee.

RESULTS

The PPS was conducted for 298 patient beds at the HNDJRE across the pediatric unit (76.8 %) and the pediatric intensive and neonatology intensive care units (23.1 %). The patients' demographic characteristics are presented in Table 1.

Table 1. Demographic characteristics of survey participants at the Hospital del Niño Dr. José Renán Esquivel

Characteristic		No. (%)
Sex	Male	161(54.3)
	Female	137 (45.9)
Age, years		
	< 1	195 (65.4)
	1-4	57 (19.1)
	5-17	46 (15.4)

Source: Point Prevalence Survey, HDNJRE, Panama City, Republic of Panama, August-September 2023

During the study period, 176 patients received antimicrobials, with antibiotic prevalence of 59.0%. Notably, the prevalence was higher in the pediatric intensive care unit (86.3%) and the neonatal intensive care unit (80.0%). Regarding the type of indication, 95.6% of antimicrobial prescriptions were for treatment purposes, 3.8% for prophylaxis, and the remaining 0.5% were for an unidentified reason. Pneumonia was the most common diagnosis (39.1%), followed by clinical sepsis (24.5%), other reasons (10.3%), and non-surgical infections involving skin or soft tissue (9.2%). The diagnoses are presented in Figure 1.

Ampicillin and gentamicin (17.3% and 16.9%, respectively), piperacillin/tazobactam (14.6%), and ampicillin/sulbactam (11.9%) were the most frequently prescribed antibiotics. Carbapenems (6.2%), third generation cephalosporins (6.2%), and vancomycin (1.1%) were among the other agents written (Figure 2).

Overall, 32.6% of antibiotics were prescribed for hospital-acquired infections (HAIs), whereas 55.9% were for community-acquired infections (CAIs). Additionally, 10.8% of prescriptions were for medical prophylaxis and 0.5% for unknown reasons. Among the specific antibiotics, piperacillin/tazobactam (29.4%) and meropenem and amikacin (each 15.3%) were commonly prescribed for HAIs. For CAIs, ampicillin (24.6%), gentamicin (22.6%), and ampicillin/sulbactam (14.0%) were the most frequently administered antibiotics. In 61.0% of cases, prescriptions aligned with hospital guidelines (Table 2).

Regarding the AWaRe classification developed by WHO to support antibiotic stewardship efforts worldwide by categorizing antibiotics into three groups (access, watch, and reserve) by their potential to develop resistance, 68.2% of the antibiotics prescribed in the study hospital were classified as "access." Figure 3 presents the use of antibiotics at the study hospital according to the WHO AWaRe classification.

DISCUSSION

We observed a high prevalence of antibiotic use (59.0%), similar to that reported previously in hospital settings in Latin

Table 2. Antibiotic prescriptions in compliance with guidelines based on indication

Indication	Compliant, No. (%)	Not compliant, No. (%)	Insufficient information, No. (%)
Total	158 (61.2)	100 (38.8)	2
Hospital acquired infection	45 (59.2)	31 (40.8)	2
Community acquired infection	94 (62.6)	56 (37.3)	0
Prophylaxis	18 (60.0)	12 (40.0)	0
Unknown	0	0	2

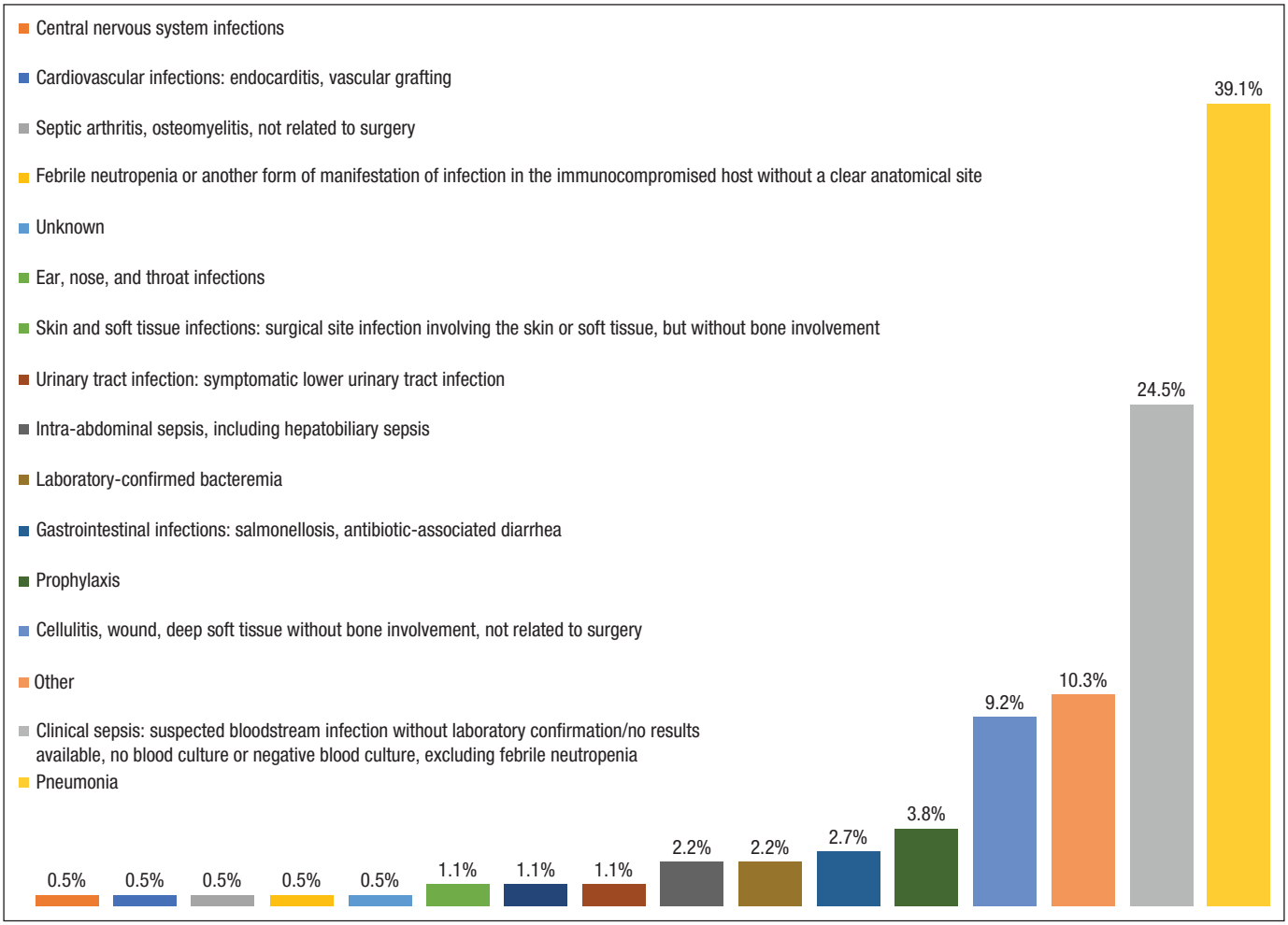
Source: Point Prevalence Survey, HDNJRE, Panama City, Republic of Panama, August-September 2023

America (8) and Africa (10-12), and higher than reported in Europe and Canada (13-15). However, most of those studies were conducted among the general public, not the pediatric population. To our knowledge, there is no comparable data for pediatric PPS in Latin America. Similar surveys conducted in pediatric populations in other LMICs such as India (61.5%), Iran (66.6%), and Nigeria (79.9%) found a high prevalence of antimicrobial use (16-18), whereas those conducted in the United States, Sweden, and the United Kingdom showed a prevalence of less than 40.0% (19-21). Similar to our findings, lower respiratory tract infections and sepsis were the most frequently treated infections in pediatric surveys performed in Canada and Italy (22, 23).

Prescription rates in specialized wards (i.e., pediatric and neonatal intensive care units) in our findings were similar to those reported by other studies (24, 25). The predominance of treatment prescriptions was consistent with the typical pattern observed in hospital settings, in which treatment of infections is the primary indication for antibiotic use (8, 14, 26). The low rate of antibiotic prophylactic use (3.8%) in our study may be explained by the low volume of surgical procedures at the time that the survey was performed.

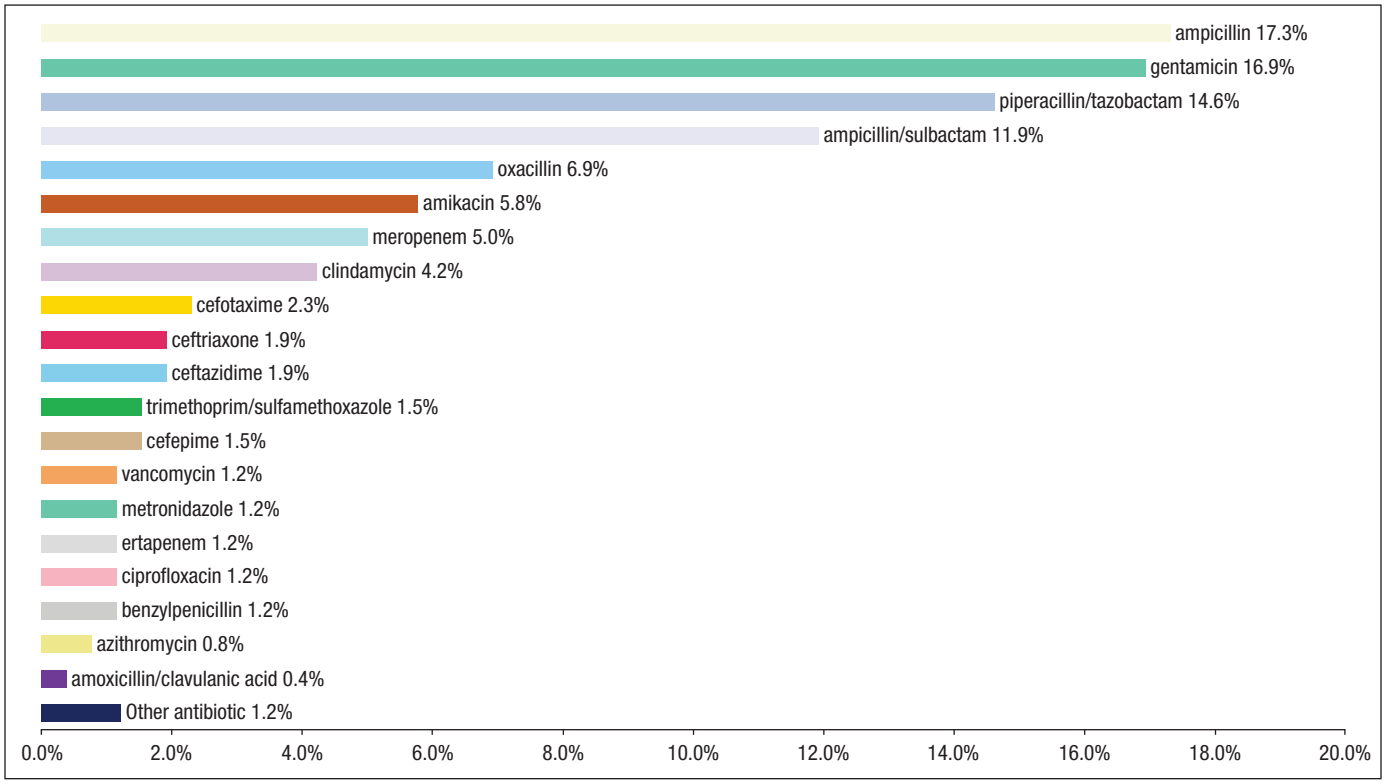
Our study results revealed that approximately 26.0% of antibiotic prescriptions fell into the "other" category. This finding may be associated with the diverse range of diagnoses managed by the hospital (Figure 2) and suggests that this group may be a target group for antimicrobial optimization or an opportunity to discourage the use of antimicrobials at all. This percentage exceeds the WHO recommended goal of 60% (27) and is higher than the rates reported in pediatric PPS populations in London (28) and China (29). From the "watch" group of the AWaRe classification, piperacillin-tazobactam (15%) was a commonly prescribed antibiotic for various indications (HAIs,

Figure 1. Diagnosis-specific antibiotic prescriptions at the Hospital del Niño Dr. José Renán Esquivel



Source: Point Prevalence Survey, Hospital del Niño Dr. José Renán Esquivel, Panama City, Republic of Panama, August-September 2023

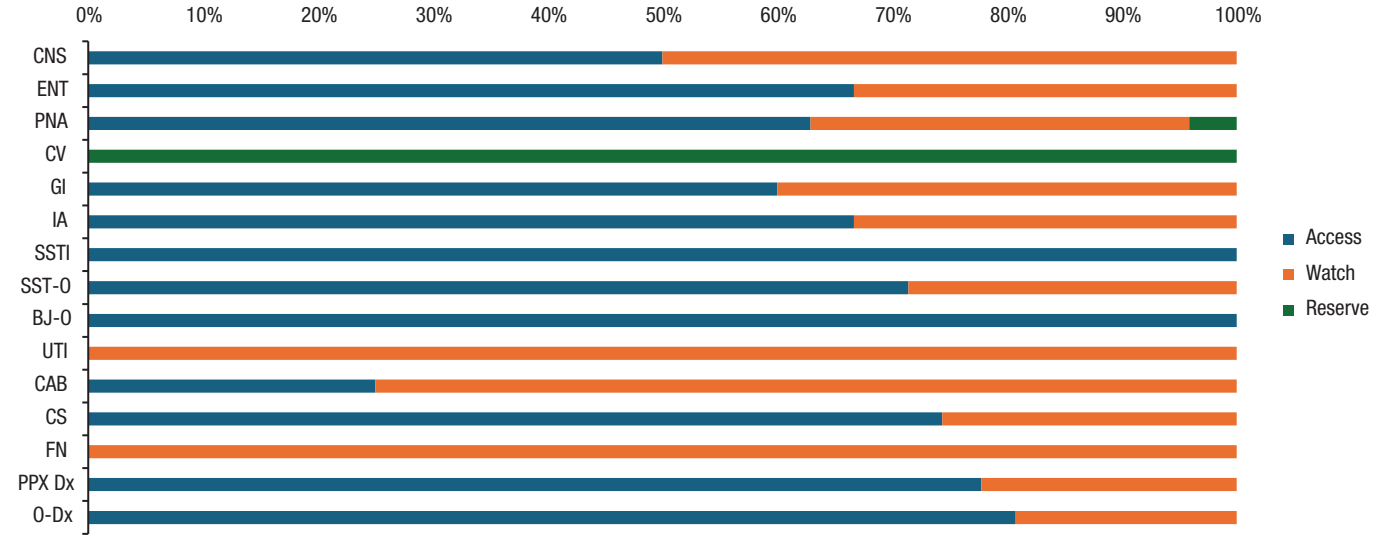
Figure 2. Distribution of antibiotics prescribed at the Hospital del Niño Dr. José Renán Esquivel



Source: Point Prevalence Survey, Hospital del Niño Dr. José Renán Esquivel, Panama City, Republic of Panama, August-September 2023

CAIs, pneumonia, prophylaxis, intra-abdominal sepsis, symptomatic lower urinary tract infection, clinical sepsis) in our study. This is not exclusive to Panama, as other studies have shown the overuse of this and other antibiotics classified in the same group (30-32). This suggests an opportunity for antimicrobial optimization by our institutional ASP. Carbapenems and

Figure 3. Antibiotic utilization by WHO AWaRe classification (Access, Watch, Reserve) at the Hospital del Niño Dr. José Renán Esquivel



Source: Point Prevalence Survey, Hospital del Niño Dr. José Renán Esquivel, Panama City, Republic of Panama, August-September 2023
CNS: central nervous system infections; ENT: ear, nose, and throat infections; PNA: pneumonia; CV: cardiovascular infections: endocarditis, vascular grafting; GI: gastrointestinal infections: salmonellosis, antibiotic-associated diarrhea; IA: intra-abdominal sepsis, including hepatobiliary sepsis; SSTI: skin and soft tissue infections: surgical site infection involving the skin or soft tissue, but without bone involvement); SST-O (cellulitis, wound, deep soft tissue without bony involvement, not related to surgery); BJ-O septic arthritis, osteomyelitis, not related to surgery; UTI: urinary tract infection or symptomatic lower urinary tract infection; CAB: catheter-associated bacteremia: laboratory-confirmed bacteremia; CS: clinical sepsis; FN: febrile neutropenia or another form of manifestation of infection in the immunocompromised host without a clear anatomical site; PPx Dx: prophylaxis; O-Dx: other diagnosis.
Patients with unknown diagnoses were excluded.

third-generation cephalosporins were less frequently reported in our PPS compared to other surveys in pediatric and non-pediatric settings (8, 25, 26).

In contrast with previous reports in which third-generation cephalosporins were the most frequently used antibiotics to treat HAIs and CAIs (8, 33), our results showed that beta-lactamase inhibitor combinations, carbapenems, and aminoglycosides were used most to treat these infections. This is because in 2009 our hospital began specifically restricting use of third-generation cephalosporins in the neonatal and pediatric intensive care areas. Pneumonia stands out as the leading reason for antimicrobial use, likely due to its high prevalence (30, 34). The high prevalence of antibiotic use for HAIs in our survey highlights the need for increased infection control measures to reduce antibiotic resistance, improve patient safety, and reduce health care costs associated with these infections.

The observed guideline compliance highlights both areas of adherence and opportunities for improvement. While the level of compliance indicates a moderate adherence to established antibiotic guidelines, there is room for improvement to ensure optimal patient outcomes and to mitigate the risks associated with antibiotic misuse. The ASP at HNDJRE aims to improve clinical outcomes, reduce adverse events related to the use of antibiotics, and ensure cost-effective therapies. Based on the results of this PPS, activities such as clinician education, regular audits after antibiotic initiation, switch from intravenous to oral therapy, incorporation of other health professionals into the team (e.g., resident physicians, interns, and nurses), and therapeutic monitoring of medications by the pharmacy department can be implemented to enhance patient safety and to strengthen the ASP. These findings emphasize the importance of continued antibiotic use surveillance and monitoring to optimize prescribing practices and combat antibiotic resistance.

Strengths and limitations

The main strength of our study is that, to our knowledge, this is the first PPS conducted in the pediatric population in Panama and Latin America, providing information on the prevalence of CAIs, HAIs, antibiotic prevalence use, and associated variables. In addition, the tool used was based on a methodology approved by PAHO and already validated in 43 hospitals in the Latin America.

Our study had some limitations. Although, HNDJRE is the primary pediatric hospital in Panama, it treats only a sample of the capital's population, and therefore, the analyses did not include the pediatric population of other cities in Panama. Also, our data collection focused on the pediatric population, which makes comparisons with other studies difficult because they include both children and adults. Another important limitation was the lack of interaction with the prescribers when completing the survey.

Conclusions

The findings of this PPS indicate that in our pediatric cohort, the prevalence of antibiotic use in the HNDJRE was similar to that reported for all age groups in Latin America. With these PPS results, we plan to assess the need for the use of ampicillin, gentamicin, and betalactam/betalactam inhibitor combination, with special emphasis on patients with sepsis and pneumonia admitted to the pediatric and neonatal critical care units. We also plan to monitor the prescribing of carbapenems and broad-spectrum cephalosporins.

We encourage hospitals in Latin America to perform PPSs focused on the pediatric population, publish data to compare with our results, determine whether there are differences among pediatric and adults, and add evidence-based literature to set policies and objectives for pediatric ASP.

Author contributions. PL, JPD, and GLH conceived the idea, developed the study protocol, and performed data analysis. XN, DE, EZ, and JL collected the information. XN was responsible for ethical approval, planning and study coordination. XN and DE were involved in drafting the manuscript. All authors reviewed and approved the last version.

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Conflicts of interest. None reported.

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Encuesta de prevalencia puntual del uso de antibióticos en un hospital pediátrico de nivel terciario en República de Panamá

RESUMEN

Objetivo. Realizar una encuesta de prevalencia puntual (EPP) del uso de antibióticos en el principal hospital pediátrico de nivel terciario de la ciudad de Panamá para establecer la prevalencia del uso de antibióticos y determinar cuestiones clave para abordar la resistencia a los antimicrobianos.

Métodos. Esta EPP realizada en un hospital de nivel terciario de Panamá se llevó a cabo utilizando la adaptación de la Organización Panamericana de la Salud de la metodología propuesta por la Organización Mundial de la Salud para las EPP del uso de antibióticos. Se obtuvo información sobre las características demográficas de los pacientes, las prescripciones de antimicrobianos, la indicación para el uso de los antimicrobianos y la adhesión de la prescripción a las directrices.

Resultados. De los 298 pacientes incluidos en la encuesta entre agosto y septiembre del 2023, 176 (59,0%) recibieron tratamiento antibiótico. La unidad de hospitalización de pediatría (86,3%) y la unidad de cuidados intensivos neonatales (80,0%) fueron las que presentaron la mayor prevalencia de uso de antibióticos. Las infecciones hospitalarias motivaron el 32,6% de las prescripciones de antibióticos, y las medicaciones más prescritas fueron la combinación de piperacilina y tazobactam (29,4%), el meropenem (15,3%), la amikacina (15,3%) y la combinación de ampicilina y sulbactam (10,2%). El tratamiento de las infecciones contraídas fuera del hospital supuso el 55,9% de las prescripciones de antibióticos, y las medicaciones más utilizadas fueron la ampicilina (24,6%), la gentamicina (22,6%) y la combinación de ampicilina y sulbactam (14,0%). El 61,0% de las prescripciones consideradas en el análisis se ajustaban a las directrices del hospital.

Conclusiones. Esta EPP detectó una prevalencia alta del uso de antibióticos. Los resultados sugieren que es necesario evaluar la necesidad de uso de la ampicilina, la gentamicina y la combinación de piperacilina y tazobactam en los pacientes ingresados en unidades de cuidados intensivos pediátricos, con especial énfasis en los pacientes con diagnósticos de neumonía o sepsis, las patologías más frecuentes para las que se prescribió un antimicrobiano.

Palabras clave Farmacorresistencia microbiana; programas de optimización del uso de los antimicrobianos; prevalencia; pediatría; Panamá.

Estudo de prevalência pontual de antibióticos em um hospital pediátrico terciário na República do Panamá

RESUMO

Objetivo. Realizar um estudo de prevalência pontual sobre o uso de antibióticos no principal hospital pediátrico de nível terciário da Cidade do Panamá para determinar a prevalência de antibióticos e identificar as principais áreas para abordar a resistência aos antimicrobianos.

Métodos. Esse estudo de prevalência pontual realizado em um hospital de nível terciário no Panamá seguiu a adaptação feita pela Organização Pan-Americana da Saúde da metodologia proposta pela Organização Mundial da Saúde para esse tipo de estudo sobre o uso de antibióticos. As informações obtidas incluíram características demográficas dos pacientes, prescrições de antimicrobianos, indicação do uso de antimicrobianos e adesão das prescrições às diretrizes.

Resultados. Dos 298 pacientes pesquisados de agosto a setembro de 2023, 176 (59,0%) foram tratados com antibióticos. A ala pediátrica (86,3%) e a unidade de terapia intensiva neonatal (80,0%) apresentaram a maior prevalência de uso de antibióticos. As infecções hospitalares foram responsáveis por 32,6% das prescrições de antibióticos. Os mais prescritos foram piperacilina/tazobactam (29,4%), meropeném (15,3%), amicacina (15,3%) e ampicilina/sulbactam (10,2%). O tratamento de infecções adquiridas na comunidade representou 55,9% das prescrições de antibióticos, e os mais usados foram ampicilina (24,6%), gentamicina (22,6%) e ampicilina/sulbactam (14,0%). Das prescrições consideradas na análise, 61,0% aderiram às diretrizes do hospital.

Conclusões. Esse estudo de prevalência pontual apontou uma alta prevalência no uso de antibióticos. Os resultados sugerem que é necessário avaliar a necessidade do uso de ampicilina, gentamicina e piperacilina/tazobactam em pacientes internados em unidades de terapia intensiva pediátrica, especialmente em crianças com diagnóstico de pneumonia e sepse, as patologias mais comuns para as quais foram prescritos antimicrobianos.

Palavras-chave Resistência microbiana; gestão de antimicrobianos; prevalência; pediatria; Panamá.