**A Multicenter Point Prevalence Survey of Antibiotic Use in Punjab, Pakistan:**

**Findings and Implications**

**Running Title:** A Multicenter Point Prevalence Survey of Antibiotic Use

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**Abstract:**

***Objective:*** In line with the recent global action plan for antimicrobial resistance, the first time such a comprehensive survey has been undertaken in Pakistan, sixth most populous country.

***Method:*** This point prevalence survey (PPS) was conducted in 13 hospitals among 7 different cities of Pakistan. The survey included all inpatients receiving an antibiotic on the day of PPS. A web-based application was used for data entry, validation, and reporting as designed by the University of Antwerp.

***Results:*** Out of 1954 patients, 1516 (77.6%) were treated with antibiotics. Top three most reported indications for antibiotic use were prophylaxis for obstetrics or gynaecological indications (16.5%) and gastrointestinal indications (12.6%) and lower respiratory tract infections (12.0%). Top three most commonly prescribed antibiotics were ceftriaxone (35.0%), metronidazole (16.0%) and ciprofloxacin (6.0%). Out of total indications, 34.2% of antibiotics were prescribed for community-acquired infections (CAI), 5.9% for healthcare-associated infections (HAI), and 57.4% for either surgical or medical prophylaxis. Of total surgical prophylaxis, 97.4% of antibiotics were given for more than one day.

***Conclusion:*** Study concluded that unnecessary prophylactic antibiotic use is extremely high and broad-spectrum prescribing is common. There is a considerable need to work on a national action plan of Pakistan on antibiotic resistance.

**Keywords:** Point Prevalence Survey, Antimicrobial Prescribing, Antimicrobial Resistance, Hospitals, Pakistan

1. **INTRODUCTION**

Infectious diseases were the major cause of death in humans until 1911 when the first antibiotic agent was introduced as a “magic bullet” [1,2]. Since their development, the significant role of antibiotics in saving lives has been evident [3]. However, all these benefits are related to their rational use [4]. Unfortunately, the irrational use of antibiotics increases the risk of development of antimicrobial resistance (AMR), increasing morbidity, mortality and costs, with costs including additional visits to emergency departments, extra prescriptions for adjuvant therapies as well as prolonged hospital stay, leading to worldwide calls to address this [5-13]. For example, colistin has re-emerged as a valued antibiotic despite its side-effects because of the emergence of carbapenem-resistant gram-negative bacteria [14,15]. This has resulted in a number of countries, including South Africa, to develop programmes to limit its use to preserve its effectiveness [16], with colistin also now included in the WHO reserve list of antibiotics [17]. According to the Council for Appropriate and Rational Antibiotic Therapy (CARAT), criteria for optimized antibiotic therapy include therapeutic safety and benefits, evidence-based results, cost-effectiveness and the optimal antibiotic for the optimal duration [18]. Appropriate dosing regimens should be adopted by following guidelines for antibiotic prescribing [18,19].

Data on antibiotic use in healthcare settings in Pakistan are currently scarce. We are aware of the excessive use of antibiotics in ambulatory care [20-22]. However, only a few published studies are available regarding the pattern of antibiotic use in Pakistan in hospitals [23,24] including their irrational use [25]. We are also aware that there have been initiatives to try and improve antibiotic use using antibiotic stewardship programmes (ASP) in Pakistan [26]. Contrary to other countries and continents including Africa, Americas, Asia, Australia, Europe, Kenya, and Turkey [27-36], no point prevalence survey (PPS) to evaluate antimicrobial use and resistance has so far been conducted in Pakistan. This is important to address concerns with the irrational use of antimicrobials in hospitals in Pakistan. Consequently, the main objectives of this multicenter PPS were to evaluate the prevalence of antibiotic use among hospitals in Pakistan and to describe the current pattern of antibiotic prescribing by type of patient’s characteristics, healthcare facilities, and specialties. This builds on our recently published study regarding the prevalence of hospital-acquired infections in Pakistan [37]. The findings will help inform future strategies to improve antibiotic prescribing among hospitals in Pakistan.

1. **Methodology:**
	1. **Study Design:**

A multicenter PPS of antibiotic use was conducted using the Global-PPS method [36,38]. This standardized survey method was used to document and evaluate antimicrobial prescribing patterns at hospital, ward and patient level.

* 1. ***Study Settings:***

The study setting for this first PPS study in Pakistan was Punjab. Punjab was chosen as the study region because it is the most populous province of Pakistan. A complete list of all public, private and charity hospitals of Punjab were acquired from the Director General Health Services office, Department of Health, Government of the Punjab, Pakistan. The hospitals from public, private and charity hospital groups from the different cities in Punjab, Pakistan were invited to participate in this survey. In case of refusal of the first selected hospital, the next health care setting on the list was selected. Participation of the hospital was voluntary. Thirteen hospitals from geographically and economically different cities of Punjab agreed to participate in the survey, which provided a representative insight into current antimicrobial prescribing practices. The health care facilities providing only nursing care, rehabilitation centers or psychiatric centers were not included in line with other PPS studies [36,39].

* 1. ***Instrument of Measure:***

Standardized paper data collection forms were used to collect data at each hospital, ward and patient level. The hospital data form included the type of the hospital, departments, number of hospitalized patients, single-room bed capacity and total bed capacities of the surveyed hospital. A review of the availability of antibiotics in the hospital formulary was checked before data collection. The Ward data form included the department specialty, total bed capacity and the total number of admitted patients (denominator data).The Patient data form included the age, gender, reason for antibiotic prescribing, the prescribed antibiotics dosage regimen, the antibiotic prescription ratio active, and the causative microorganisms. For the dose of a combination antimicrobial, the sum of each antibiotic substance excluding the enzyme inhibitors was recorded. A set of quality indicators included whether the reason for the prescription and a stop/review date was written in the notes; and whether the antibiotic was prescribed according to the guidelines if this existing, with the latter increasingly indicative of quality prescribing [36,40,41]. A web-based application was used for data-entry, validation, and reporting as designed by the University of Antwerp [36,38].

* 1. ***Inclusion criteria:***

All in-patients that stayed overnight and remained in the ward at 08:00 am on the day of the survey were included. Data were collected only from those patients who were receiving at least one antimicrobial for at least one clinical treatment condition or prophylaxis at the time of the survey. Beside antibacterials for systemic use, the survey included also antimycotics, antifungals and antivirals for systemic use infections in more than one site in the same patient were reported as separate infections.

* 1. ***Exclusion criteria***

Short stay patients that did not stay overnight, those discharged patients before 08.00 am on the day of the survey that were waiting for transport to their dwelling, patients admitted after 8am on the day of the survey, patients staying in long-term care units including dialysis centers and patients in emergency and outpatient departments were not included.

* 1. ***Data Collection:***

The data were collected using a structured data collection tool [36,38]. All patients admitted on the ward at 08.00 am on the day of the survey were counted in the denominator. Whereas, all inpatients on antimicrobials at 08.00 am were included in the numerator, and forms were completed for these patients only. All the prescribed antimicrobials at the time of the survey were included. Patients were included as part of the initial ward of admittance if transferred to another ward after 8.00 a.m. All neonates born before 08.00 am on the day of the survey were also included. The surgical wards were not surveyed on a day following a holiday but on the other days of the week in order to capture information about prophylaxis in the last 24 hours [36]. Surgical prophylaxis included prophylactic agents to prevent surgical site infections. Long-acting antibiotics and intermittent treatment on alternative days were also included if given 24 hours before the survey. Medical prophylaxis was defined as the use of antibiotics to prevent infections in patients with medical conditions [36]. Infections were considered as community-acquired infections (CAIs) if symptoms started <48 hours from admission to hospital (or present on admission), and hospital-acquired infections (HAIs) if symptoms started 48 hours after admission [36]. The last prescribed antibiotic was recorded if the antibiotic prophylaxis or treatment was changed on the day of the survey before or at 08.00am. Additional details of the variables from the patient’s medical case notes and prescribing charts were recorded after discussions with nursing staff and physicians if pertinent. However, in most cases, only the patients’ notes were reviewed in order to gain a good understanding of the current situation especially if crucial data was left out such as the rationale for antibiotic selection. The data were double checked for completeness and accuracy in order to rule out missing or inconsistent data. There was no contact with any patient at any moment. All the data were entered onto the web-based Global-PPS application [38]. Data from all wards of a single hospital were collected within 2-4 weeks. In order to minimize the effect of movement of patients between wards and within the hospital, each ward was completely surveyed within one day. The process of data collection was completed between October 2017 and February 2018. The Anatomical Therapeutic Chemical (ATC) classification system of the WHO was used to classify the different antibiotics used [42].

* 1. **Ethical Considerations:**

Application for Ethical clearance prior to the conduct of the study was sought from the Human Ethics Division of University College of Pharmacy, University of the Punjab, Lahore (HEC/1000/PUCP/1925B). Subsequent approval to conduct the study in the identified hospitals was obtained from the hospital management. All collected data were anonymized during the time of data collection.

* 1. **Statistical Analysis**

Data were analyzed using the latest versions of Microsoft Excel and SPSS (version 22 IBM, California, USA). On categorical variables, descriptive statistics (frequency, percentages, mode, and medians) were applied. Continuous variables were presented with median and range.

1. **Results:**

A total of 13 hospitals with 3074 beds were surveyed in this prevalence study from seven different cities of Pakistan. The survey was conducted in five private and eight public sector hospitals including secondary, tertiary and specialized health care facilities. Basic patient data from the different hospitals treated with antimicrobials is presented in Table 1. During this PPS, 1954 (63.6% bed occupancy) patients with a median age of 35 years were hospitalized on the day of the survey. Out of these, 1516 patients (77.6%) were treated with one or more antimicrobials of which 1503 patients received at least one antibiotic for systemic use (76.9%; ATC code J01). There was an appreciable variation in antibiotic use prevalence across the hospitals, ranging from 50.9%-100% of all patients in the hospital.

The total number of prescribed antimicrobials was 2483 (J01; 96.6%, J02; 0.4%, J04; 0.8%, J05; 0.8%, P01; 0.6%, A07; 0.7%) (Table 2), of whom 1177 (47.7%) were given to male patients and 1306 (52.6%) were given to female patients. The average number of antimicrobials prescribed per patient (1.64) ranged from 1.14 to 1.97 antimicrobials per patient. Nine hundred and sixty-one (38.7%), 1,404 (56.5%) and 118 (4.8%) antibiotics were prescribed in surgical departments, medical departments, and ICU, respectively (Table 1). Parenteral (91.5%) antibiotic use was very prevalent. Of the total prescribed antibiotics, 55.5% were prescribed to patients in the age group 25-65 years, followed by 26.3%, 8.9%, 6.5% and 2.7% to patients in the age groups 1-25 years, above 65 years, 1 month-1 year and less than 1 year respectively (Appendix 1). The admitted patients were more likely to receive antibiotics as prophylaxis (57.4%). Of the total 1,426 antibiotics for prophylactic use, 893 (62.6%) were used for surgical prophylaxis whereas 533 (37.4%) were prescribed for medical prophylaxis. Most of the antibiotics for surgical prophylaxis were given for more than one day (97.4%). For the management of infections, 850 (85.3%) antibiotics were given for CAIs whereas 147 (14.7%) were given for HAIs.

In the majority of cases, the reasons for prescribing the various antibiotics were not mentioned in the patient’s medical file (76.2%). Only 57 culture reports were found at the time of the survey as most of the antibiotics were prescribed empirically (96.2%). Fifty-eight different types of antibiotics were used, but just two (ceftriaxone and metronidazole) comprised 51% of all antibiotic treatment. Most of the hospitals were using 20 different types of antibiotic substances, ranging from 9-30. Of the total number of antibiotics prescribed, 772 (50.9%) patients were prescribed one antibiotic, 558 (36.8%) were prescribed two antibiotics and 186 (12.3%) patients were prescribed three or more antibiotics.

 Most of the surveyed patients were admitted into the general medical wards (25.0%), surgical wards (18.4%) and obstetrics and gynecology wards (14.4%). Other than these wards, all other wards were also surveyed as per the hospital specialty. The details about the use of the different antimicrobials in the different clinical wards and medical indications are summarized in Tables 3 and 4. Appendixes 2 to 4 provide details at the hospital level. Obstetric or gynecological prophylaxis (16.5%), gastrointestinal prophylaxis (12.6%), lower respiratory infections (12.0%) and general medical prophylaxis (10.5%) were the most common clinical indications for antibiotic use.

The top three most commonly prescribed antibiotics were ceftriaxone (35.0%), metronidazole (16.0%) and ciprofloxacin (6.0%) (Table 3). Ceftriaxone remained the most used antibiotic for different treatments or prophylactic use, ranging from on average 12.7% of use in the ICU to on average 40.4% of use in the medical departments (Table 4). In addition to these top three commonly used antibiotics, there was a relatively high use of amikacin (11.0%), meropenem (10.2%), piperacillin and enzyme inhibitor (10.2%) and vancomycin (9.3%) was observed among ICU patients compared to other departments. Metronidazole IV was highest for surgical prophylaxis (26.7%). Ampicillin was most frequently used in neonates (8.8%) and infants (20.8%). Moxifloxacin was frequently prescribed among patients aged 25-65 years (4.4%) and age above 65 years (9.0%). It proved impossible to assess the quality of prescribing as currently there are no accepted national guidelines giving advice on antimicrobial prescribing [43].

1. **Discussion:**

Effective surveillance of antibiotic use is invaluable to help rationalize antibiotic prescribing, thereby helping control the emergence of multidrug resistance microbes, observing the efficiency of policies, identifying targets for quality improvement and informing the policymakers [7,9,28,44,45]. The global threat of increasing AMR prompted us to conduct this first point prevalence survey among selected hospitals of Pakistan [10]. In the present study, 77.6% of admitted patients on one single day had consumed at least one antimicrobial. This is much higher than prevalence rates reported in other PPS studies across the world including the Global PPS (34.4%), Europe (27.4% - 34.4%%), Asia including China (37.2% - 55.6%), North America (38.6% - 50.0%) and Turkey (30.6%) [28,32-34,36,44]. However, this is similar to some of the hospitals seen in the Global PPS study, particularly the African countries, as well as Botswana and Kenya [36,46,47] but not Ghana (51.4%) [48]. In Botswana, more than two-thirds of admissions in their PPS study were due to infectious diseases with 40% of those tested were HIV positive [47]. In addition, our results are comparable with other hospitals in China (75.3%) [49], which has already resulted in the instigation of antibiotic stewardship strategies in China to address antibiotic overuse [50-52]. Among the identified regions worldwide, the highest use of antibiotics was seen in intensive care units (ICU) of Vietnam (84.6%) among the adult population [53]. In the Global PPS, up to 69.7% of patients in ICU were prescribed an antibiotic [36], similar to the findings in Kenya [46]. We also saw a high use of antibiotics in ICU.

There was also a high use of antibiotics for medical prophylaxis in our study (37.4% of 57.4% of patients who received an antimicrobial). This is similar though to the situation seen in Kenya (29% of antimicrobial use) but much lower than seen in the Global PPS (7.4%) [36,46]. The reasons for this high rate are currently unknown; however, this will be investigated further to reduce inappropriate antimicrobial prescribing. Approximately 50% of patients were prescribed two or more antibiotics in our study, which is similar to a study conducted in America [33]. We believe this high rate of combination antibiotic treatment is needed to increase the spectrum of antibiotics prescribed without the support of a culture report. This is also a concern that needs to be addressed, and we will be pursuing this in future projects. In the present study, the most commonly prescribed antibiotic was ceftriaxone (35%) which is comparable to a study from China [49], with ceftriaxone included in the WHO list of Access antibiotics [17]. In other regions, however, such as in 183 hospitals of the USA, the prevalence of ceftriaxone use was only 10.8% [33]. The majority of antibiotics prescribed were also on the WHO list of Access antibiotics (Table 3), with moxifloxacin, piperacillin with an enzyme inhibitor and cefoperazone on the Watch list [17]. Their use will be the subject of future research projects.

In the present study, ceftriaxone was also commonly prescribed for surgical prophylaxis, similar to a number of regions in the Global PPS particularly Africa as well as in Kenya for surgical prophylaxis [36,46]. The routinely use of ceftriaxone for prophylaxis in our study is of concern as it should not routinely be used for prophylaxis [54]. Inappropriate ceftriaxone use can lead to the emergence of multidrug-resistant strains if not addressed [55,56]. There is also concern that antibiotics for surgical prophylaxis were given for more than one day (97.4%), which is against current guidance as this can increase AMR rates [57,58]; however, this is similar to the situation seen in other countries [36,46,59]. The threat of surgical site infections should not be ignored while following guidelines [60,61]. A number of studies have highlighted that even in the most documented evidence-based area of practice, physicians are inclined to prescribe antibiotics for more than 24 hours [62]. As a result, physicians should be encouraged to write the reason to start antibiotic treatment, document the start date and follow up the duration of use in the patient’s medical notes. This will be followed up in future studies. The high use of ceftriaxone in this study also suggests cheap, easy or free availability and affordability, which needs to be researched further [63].

As mentioned, there are almost no local or national guidelines or recommendations for empiric antibiotic use in hospitals in Pakistan [43]. Our results suggest the urgent need to develop these starting with guidelines for the most common indications as well as for surgical and medical prophylaxis. This could be part of an ASPs to be developed at a national level, and could also be part of the national action plan of Pakistan for AMR [64]. The UK, for example, has successfully managed to reduce the use of the third-generation cephalosporins by introducing antimicrobial stewardship programs [65,66], providing guidance to others. In addition, a lower proportion of broad-spectrum antibiotics indicates better practice [67]. It is also important that ASP also include quality targets, a timeline as well as a dedicated budget to achieve desired goals. However, it is acknowledged that it is more challenging introducing ASPs in LMICs due to a number of issues including manpower challenges [68].

Variations in antibiotic use patterns may also be due to differences in the spectrum of diseases and the facilities across countries and regions; however, this needs to be investigated further before any definitive statements can be made. There is also likely to be variation among the departments in the pattern of antibiotic use within hospitals in Pakistan. For example, large and specialized hospitals have more immunocompromised or severely injured and ill patients, or those in need of complex surgical procedure, as compared to small hospitals affecting utilization patterns [31]. Encouragingly, the use of quinolones in the present study is comparable to most of the European countries but less than those reported in France [31,69,70]. Overall, the extensive use of broad-spectrum antibiotics in Pakistan could be explained by high bacterial resistance rates [71], and the potential for practitioners to overprescribe antibiotics if they view such practices as a viable way to ensure a speedy recovery [72,73]. Additionally, physicians in Pakistan may be influenced by pharmaceutical companies if they are the principal source of information as seen in other settings in Pakistan and other countries [21,74-76].

Another concern is the very high usage (91.5%) of parenteral antibiotics observed in this study as compared to previously published PPS studies [45]. We believe this goes hand in hand with the high use of third-generation cephalosporins (ceftriaxone) for which no oral equivalent is currently available. Nevertheless, many physicians and patients consider that parenteral therapy is superior and more effective than oral administration [77]. Moreover, the use of parenteral antibiotics is inevitable in case of life-threatening infections, the age of the patient especially infants, and the availability of dosage form. Whenever possible though, each hospital should develop individual guidelines to switch from intravenous to oral treatment in view of the several clinical and economic benefits associated with timely conversion to oral from intravenous therapy [78,79]. In our study, physicians of only one specialized cancer care hospital were found to prescribe fewer antibiotics (50.9%) as per the advice of pharmacists. The literature supports the fact that interventions of a pharmacist by interacting directly in the ward with physicians can play an important role in optimizing antibiotic prescribing, leading to a decrease in health care costs and days of hospitalization [80,81]. This will also be followed up in future studies.

Finally, as seen, prophylactic antibiotic use without culture reports was high, relatively much higher in smaller hospitals of those surveyed. This reflects the general lack of reporting the rationale for antimicrobial use. As a result, as mentioned, physicians should be encouraged to write the reason to start antibiotic treatment in the patient’s medical notes. The present study has a number of limitations. Firstly, it was impossible to assess the appropriateness of antibiotic therapy in terms of choice and duration. Nonetheless, surveillance is the first step in identifying, appraising and progressing the existing situation with respect to inappropriate antibiotic prescribing. Secondly, a number of patient’s medical notes were not sufficient to evaluate the diagnosis of infection. This may have underestimated or overestimated infection rates. Thirdly, as this was the first PPS in these hospitals, sequential surveys should be conducted to reveal any seasonal changing epidemiology among the hospitals [82]. Lastly, because participation of hospital was solely voluntary, data cannot be generalized to the whole of Pakistan because only a few hospitals of one Province participated in the survey. In spite of the above-mentioned limitations, the present survey provides insight into the prevalence and pattern of antibiotic use in Pakistan. The outcomes of this survey highlight the significance of surveillance of antibiotics and the need of antibiotic policies to enhance the appropriate use of antibiotics in the future. The findings of this survey could be the basis for planning future goals for appropriate management of antibiotic use and antibiotic stewardship including developing pertinent quality indicators based on previous studies [36,40]. The important features of this methodology are its ease of use and cost-effectiveness.

1. **Conclusion and recommendations:**

There is considerable cause for concern regarding the current use of antibiotics in hospitals in Pakistan. Consequently, there is an urgent need to start working on a national action plan in Pakistan in order to rationalise the use of antibiotics. Stewardship efforts, in particular, should be focused on the use of ceftriaxone especially any prophylactic use, the length of prophylaxis and the reasons for antibiotic prescribing in the first place. In addition, the rapid conversion to oral antibiotics should be implemented where pertinent. To preserve the future effectiveness of antibiotics and reduce patient harm due to AMR, it is imperative to rationally scrutinize and improve the prescribing practices. The study is a first step to provides an insight into antibiotic use among Pakistani hospitals and highlights directions for improvement of antibiotic prescribing quality. Taken together, a multifaceted policy that includes regulation, collaboration, education, and increased financial support is required at the national level in Pakistan. Future studies can also be part of the Global PPS study to enhance comparisons with other LMICs.

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**Conflict of interest**

The authors declare that there are no actual or potential conflicts of interest in relation to this article.

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**\*of importance, \*\* of considerable importance**

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**Table 1:** Overall antibiotic use prevalence

|  |
| --- |
|  |
| **Characteristics N (%)** | **Hosp. A i** | **Hosp. B** | **Hosp. C** | **Hosp. D** | **Hosp. E ii** | **Hosp. F iii** | **Hosp. G ii** | **Hosp. H** | **Hosp. I** | **Hosp. J** | **Hosp. K** | **Hosp. L** | **Hosp. M** | **Total** |
|  |
| Hospital Type | Public | Charity | Public | Private | Charity | Charity | Public | Public | Public | Private | Public | Public | Public |  |
| Total beds | 451 | 233 | 86 | 67 | 190 | 195 | 361 | 166 | 107 | 239 | 282 | 355 | 342 | 3074 |
| Hospitalized patients | 373 (82.7) | 102 (43.7) | 72 (83.7) | 36 (53.7) | 93 (48.9) | 161 (82.6) | 212 (58.7) | 96 (57.8) | 75 (70.1) | 106 (44.4) | 112 (39.7) | 286 (80.6) | 230 (67.3) | 1954 (63.6) |
| Number of treated patients | 281 (75.3) | 97 (95.0) | 68 (94.4) | 27 (75.0) | 65 (69.8) | 82 (50.9) | 148 (69.8) | 79 (82.3) | 75 (100) | 89 (84.0) | 74 (66.1) | 230 (80.4) | 201 (87.4) | 1516 (77.6) |
| Prescribed antibiotics (per patient) | 481 | 149 | 122 | 51 | 108 | 140 | 291 | 105 | 127 | 134 | 84 | 338 | 353  | 2483 |
| Surgical Department N (%) | 267 (55.5) | 48 (32.2) | 73 (59.8) | 38 (74.5) | 61 (56.5) | 19 (13.6) | 73 (25.1) | 5 (4.8) | 73 (57.5) | 23 (17.2) | 48 (57.1) | 182 (53.8) | 85 (24.1) | 961 (38.7) |
| Medical Department N (%) | 208 (43.2) | 98 (65.8) | 49 (40.2) | 4 (7.8) | 40 (37.0) | 105 (75.0) | 199 (68.4) | 97 (92.4) | 54 (42.5) | 72 (53.7) | 23 (27.4) | 156 (46.2) | 265 (75.1) | 1404 (56.5) |
| Intensive Care Unit N (%) | 6 (1.2) | 3 (2.0) | 0 | 9 (17.6) | 7 (6.5) | 16 (11.4) | 19 (6.5) | 3 (2.9) | 0 | 39 (29.1) | 13 (15.5) | 0 | 3 (0.8) | 118 (4.8) |
| Male | 172 (35.8) | 63 (42.3) | 57 (46.7) | 33 (64.7) | 53 (49.1) | 84 (60.0) | 104 (35.7) | 62 (59.0) | 62 (48.8) | 67 (50.0) | 33 (39.3) | 178 (52.7) | 209 (59.2) | 1177 (47.4) |
| Female | 309 (64.2) | 86 (57.7) | 65 (53.3) | 18 (35.3) | 55 (50.9) | 56 (40.0) | 187 (64.3) | 43 (41.0) | 65 (51.2) | 67 (50.0) | 51 (60.7) | 160 (47.3) | 144 (40.8) | 1306 (52.6) |
| **Route of administration** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Oral | 31 (6.4) | 18 (12.1) | 0 | 2 (3.9) | 15 (13.9) | 25 (17.9) | 15 (5.2) | 2 (1.9) | 9 (7.1) | 25 (18.7) | 24 (28.6) | 30 (8.9) | 13 (3.7) | 209 (8.4) |
| Parenteral | 450 (93.6) | 131 (87.9) | 122 (100) | 49 (96.1) | 93 (86.1) | 115 (82.1) | 276 (94.8) | 103 (98.1) | 118 (92.9) | 109 (81.3) | 60 (71.4) | 308 (91.1) | 340 (96.3) | 2274 (91.5) |
| **Indication** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Therapeutic use | 124 (25.8) | 57 (38.3) | 37 (30.3) | 16 (31.3) | 42 (38.9) | 106 (75.7) | 112 (38.5) | 26 (24.8) | 59 (46.5) | 75 (56.0) | 36 (42.9) | 111 (32.8) | 151 (42.8) | 997 (40.2) |
| Prophylaxic use | 351 (73.0) | 83 (55.7) | 84 (68.9) | 31 (60.6) | 66 (61.1) | 34 (25.3) | 154 (52.9) | 76 (72.4) | 68 (53.5) | 54 (40.3) | 48 (57.1) | 226 (66.9) | 197 (55.8) | 1426 (57.4) |
| Unknown | 6 (1.2) | 9 (6.0) | 1 (0.8) | 4 (7.8) | 0 | 0 | 25 (8.6) | 3 (2.9) | 0 | 5 (3.7) | 0 | 1 (0.3) | 5 (1.4) | 59 (2.4) |
| **Indication for prophylaxis** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Medical | 110 (31.3) | 33 (39.7) | 25 (29.7) | 8 (25.8) | 18 (27.3) | 18 (52.9) | 34 (77.9) | 54 (71.1) | 26 (38.2) | 30 (55.5) | 18 (37.5) | 78 (34.5)  | 81 (53.6) | 533 (37.4) |
| Surgical | 241 (68.6) | 50 (61.3) | 59 (70.3) | 23 (74.2) | 48 (73.7) | 16 (47.1) | 120 (22.1) | 22 (28.9) | 42 (61.8) | 24 (44.5) | 30 (62.5) | 148 (65.5) | 70 (46.3) | 893 (62.6) |
| **Surgical prophylaxis** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Single dose | 0 | 3 (6.0) | 0 | 0 | 0 | 0 | 0 | 0 | 2 (4.8) | 1 (4.2) | 0 | 4 (2.7) | 0 | 10 (1.1) |
| One day | 5 (2.1) | 0 | 3 (5.1) | 0 | 1 (2.1) | 0 | 1 (0.8) | 0 | 0 | 0 | 0 | 3 (2.0) | 0 | 13 (1.5) |
| More than one day | 236 (97.9) | 47 (94.0) | 56 (94.9) | 23 (100) | 47 (97.9) | 16 (100) | 119 (99.2) | 22 (100) | 40 (95.2) | 23 (95.8) | 30 (100) | 141 (95.3) | 70 | 870 (97.4) |
| **Indication for infection** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Community-acquired | 116 (93.5) | 53 (93.0) | 31 (83.7) | 9 (56.3) | 32 (76.2) | 69 (65.1) | 105 (93.7) | 22 (84.6) | 55 (93.2) | 45 (60.8) | 27 (75.0) | 99 (89.2)  | 187 (94.9) | 850 (85.3) |
| Hospital-acquired | 8 (6.5) | 4 (7.0) | 6 (16.3) | 7 (43.7) | 10 (24.8) | 37 (34.9) | 7 (6.3) | 4 (15.4) | 4 (6.8) | 29 (39.2) | 9 (25.0) | 12 (10.8) | 10 (5.1) | 147 (14.7) |
| **Reason on Notes** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Yes | 88 (18.3) | 25 (16.8) | 11 (9.0) | 4 (7.8) | 3 (2.8) | 78 (55.7) | 25 (8.6) | 15 (14.3) | 44 (34.6) | 47 (35.1) | 16 (19.0) | 87 (25.7) | 147 (41.6) | 590 (23.8) |
| No | 393 (81.7) | 124 (83.2) | 111 (91.0) | 47 (92.2) | 105 (97.2) | 62 (44.3) | 266 (91.4) | 90 (85.7) | 83 (65.4) | 87 (64.9) | 68 (81.0) | 251 (74.3) | 206 (58.4) | 1893 (76.2) |
| **Empirical Therapy** | 480 (99.8) | 148 (99.3) | 122 (100) | 48 (94.1) | 104 (96.3) | 92 (65.7) | 285 (97.9) | 104 (99.0) | 127 | 107 (79.9) | 84 (100.0) | 335 (99.1) | 353 (100.0) | 2389 (96.2) |
| **Types of Generics used** | 22 | 15 | 9 | 14 | 23 | 26 | 29 | 15 | 13 | 30 | 11 | 22 | 23 | 19 |
| **Culture Reports** | 1 | 1 | 0 | 3 | 4 | 22 | 1 | 0 | 0 | 25 | 0 | 0 | 0 | 57 |
|  |
| **i Public Sector Teaching Hospital, ii Specialized Spine and Orthopedic Hospital, iii Specialized Cancer Care Hospital with advance Clinical Pharmacy Services** |
|  |

**Table 2:** Use prevalence of main antibiotics classes

|  |
| --- |
|  |
| **Antibiotics**  | **N (%)** | **Hospital range %** |
|  |
| **ANTIBACTERIALS FOR SYSTEMIC USE** (J01) | 2398 (96.6) | 85.0-100.0 |
| **Tetracyclines** (J01A)  | 23 (0.8) | 0.0-5.9 |
| **Penicillins** (J01C) | 293 (11.8) | 0.0-35.0 |
| **Cephalosporins & Penams** (J01D) | 1218 (49.1) | 0.0-70.2 |
| **Sulfonamides & trimethoprim** (J01E) | 5 (0.2) | 0.0-2.9 |
| **Macrolides & lincosamides** (J01F) | 51 (2.1) | 0.0-5.2 |
| **Aminoglycosides** (J01G) | 88 (3.5) | 0.0-11.9 |
| **Quinolones** (J01M) | 282 (11.4) | 0.0-24.6 |
| **Other antibacterials** (J01X) | 458 (18.4) | 0.0-31.1 |
| **Antimycotics for systemic use**(J02) | 11 (0.4) | 0.0-7.1 |
| **Antimycobacterials FOR SYSTEMIC USE** (J04)  | 21 (0.8) | 0.0-6.5 |
| **Antivirals FOR SYSTEMIC USE** (J05) | 21 (0.8) | 0.0-3.6 |
| **Antiprotozoals** (P01) | 15 (0.6) | 0.0-3.6 |
| **Antidiarrheals** (A07) | 17 (0.7) | 0.0-4.5 |
|  |

**Table 3:** Top 10 indications and antibiotics

|  |
| --- |
|  |
|  | **Top 10 Indications** | **Top 10 Antibiotics** |
| **No.** |  |  |
|  | **Indications** | **N (%)** | **Antibiotics**  | **N (%)** |
|  |  |  |
| **1.** | **P. OBGY** | 408 (16.5) | **Ceftriaxone**  | 868 (35.0) |
| **2.** | **P. GI** | 313 (12.6) | **Metronidazole** | 397 (16.0) |
| **3.** | **LRTI** | 297 (12.0) | **Ciprofloxacin** | 150 (6.0) |
| **4.** | **General MP** | 260 (10.5) | **Co-amoxiclav** | 91 (3.7) |
| **5.** | **SST** | 170 (6.8) | **Moxifloxacin**  | 86 (3.5) |
| **6.** | **P. BJ** | 149 (6.0) | **Piperacillin, enzyme inhibitor** | 82 (3.3) |
| **7.** | **SEPSIS** | 145 (5.9) | **Cefoperazone** | 73 (2.9) |
| **8.** | **GIT** | 118 (4.8) | **Amikacin** | 69 (2.8) |
| **9.** | **P. RESP** | 95 (3.8) | **Ampicillin** | 68 (2.7) |
| **10.** | **CNS** | 62 (2.5) | **Vancomycin** | 59 (2.4) |
|  |
| **BJ;** Bone & Joint, **CNS;** Central Nervous System, **GIT;** Gastro-Intestinal Tract, **MP;** Medical Prophylaxis, **OBGY;** Obstetric or Gynaecological, **LRTI;** Lower Respiratory Tract Infection, **P;** Medical or Surgical Prophylaxis, **RESP;** Respiratory, **SST;** Skin and Soft Tissues |
|  |

**Table 4:** Top 5 antibiotics in different conditions

|  |
| --- |
|  |
| **Study Variables**  | **Ranks** |  |
| **1** | **2** | **3** | **4** | **5** |
|  |
| **Department** |  |  |  |  |  |
| ICU | Ceftriaxone 15 (12.7)  | Amikacin 13 (11.0) | Meropanam 12 (10.2) | Piperacillin & enzyme inhibitor 12 (10.2) | Vancomycin 11 (9.3) |
| Medical | Ceftriaxone 567 (40.4) | Ciprofloxacin 58 (4.1) | Piperacillin & enzyme inhibitor 58 (4.1) | Moxifloxacin 57 (4.1) | Ampicillin 52 (3.7) |
| Surgical | Ceftriaxone 286 (29.8) | Metronidazole 218 (22.7)  | Cefoperazone 66 (6.9) | Co-amoxiclav 47 (4.9) | Cefotaxime 42 (4.4) |
|  |
| **Age Groups**  |  |  |  |  |  |
| <1month | Ceftriaxone16 (23.5) | Amikacin 11 (16.2) | Cefotaxime11 (16.2) | Ampicillin6 (8.8) | Ciprofloxacin4 (5.9) |
| 1 month-1year | Ceftriaxone70 (44.0) | Ampicillin33 (20.8) | Metronidazole10 (6.3) | Amikacin 7 (4.4) | Ceftazidime6 (3.8) |
| 1 year-25years | Ceftriaxone228 (34.6) | Metronidazole127 (19.3) | Cefotaxime32 (4.9) | Ciprofloxacin27 (4.1) | Co-amoxiclav27 (4.1) |
| 26-65years | Ceftriaxone 471 (34.2) | Metronidazole241 (17.5) | Ciprofloxacin111 (8.1) | Moxifloxacin 61 (4.4)  | Co-amoxiclav57 (4.1) |
| >65years | Ceftriaxone83 (37.6) | Moxifloxacin20 (9.0) | Metronidazole19 (8.6) | Meropenam13 (5.9) | Piperacillin & enzyme inhibitor10 (4.5) |
|  |
| **Indications** |  |  |  |  |  |
| Community acquired infection | Ceftriaxone 237 (27.9) | Metronidazole95 (11.2) | Ampicillin43 (5.1) | Vancomycin 40 (4.7) | Moxifloxacin40 (4.7) |
| Hospital acquired infection | Ceftriaxone25 (16.9) | Piperacillin & enzyme inhibitor16 (10.8) | Metronidazole13 (8.8) | Meropenam9 (6.1) | Amikacin9 (6.1) |
| Medical Prophylaxis | Ceftriaxone278 (52.2) | Metronidazole 43 (8.1) | Ciprofloxacin 31 (5.8) | Moxifloxacin24 (4.5) | Piperacillin & enzyme inhibitor18 (3.4) |
| Surgical Prophylaxis | Ceftriaxone310 (34.7) | Metronidazole238 (26.7) | Ciprofloxacin63 (7.1) | Cefoperazone54 (6.0) | Cefotaxime42 (4.7) |
| Unknown/others | Ceftriaxone18 (30.5) | Metronidazole8 (13.6) | Ciprofloxacin 5 (8.5) | Levofloxacin3 (5.1) | Co-amoxiclav3 (5.1) |
|  |