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Research Article

Incidence of Bacterial Infections in Patients at Princess Basma Teaching Hospital, Jordan for Antimicrobial Profiles

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Abstract

The goal of this study was to assess bacterial antimicrobials usage in Jordan's Princess Basma Teaching Hospital incidence and profile. The research, including samples of patients, admitted in Princess Basma Teaching Hospital, is a cross-descript and retrospective epidemiological analysis from January 2018 to December 2019. The information gathered through an investigation into the data in the Hospital Infection Control Services (HICs) map available in the current indicators. The study analyzed approximately 248 positive cultures findings in multiple topographic places, 64 (26.3%) and 72 (29%) from January to August to September to December 2018 and 66 (26.9%) and 46 (18%) respectively from January to August and September to December 2019. In view of the descriptions of this study, the use of various antimicrobials in the treating of HICs, taking into account the importance of the rational use of such substances in the current mechanisms of resistance developed by bacteria, was demonstrated. As the research performed in the hospital, drugs relating to bacterial resistance in these medical environments may be controlled more accurately, with or without indiscriminate use.

Keywords: Jordan; Teaching Hospital; Antimicrobials; Antibiotics; Retrospective analysis; Retrospective analysis.

Introduction

The term Hospital Infection means the localized, systemic disease that has occurred 48 hours or longer after hospital admission resulting from an adverse reaction to the presence or toxin of an infective agent that relates to hospitalization or hospital procedures, acquired after the admission of the patient and which manifests itself during hospitalization or after discharge, and which was not in the incubation phase at the time of hospital admission [1,2].

Antibiotics are a class of drugs used to treat these hospital infections, defined as substances produced by different species of microorganisms, such as bacteria, fungi and Actinomycetes, besides, there are antimicrobials produced in a synthetic way, such as Sulfonamides and Quinolones, that act by inhibiting the growth of other microorganisms [3]. The widespread use of antimicrobials, which is due to different factors ranging from the patient's request to uncertainties regarding the diagnosis [4], has resulted in the emergence of pathogens resistant to antibiotics, with an increasing need for new drugs, however the emergence of new ones. Antibiotics are not proportional to this need [5].

Based on the chemical structure and mechanism of action, antimicrobials are classified as: Agents that inhibit bacterial cell wall synthesis (Penicillin's, Cephalosporins, Carbapenems, Monobactams and Glycopeptides); Agents that act directly on the cell membrane of the microorganism (Polymyxins and Daptomycin); Agents that affect protein synthesis by affecting the function of the 30s ribosomal subunits (Aminoglycosides, Tetracyclines), 50S (Macrolides, Chloramphenicol) or that inhibit

protein synthesis through their binding to the P site of the 50S subunits of the ribosome preventing the formation of the largest fMet-tRNA-ribosomal complex, which initiates protein synthesis (Linezolid) [6]; Agents that inhibit the synthesis of tetrahydrofolic acid, necessary for the synthesis of nucleic acids, by competitive mechanism (Sulfonamides, Trimethoprim); Agents that inhibit topoisomerase (Quinolones) [7] and agents that affect the bacterial metabolism of nucleic acids (Rifampicin).

"Whilst antibiotics are evolutionary in selecting bacterial resistance, they also contribute to the issue, due to the spread of resistance genes and resilient bacteria. The word Multidrug Resistance (MDR) describes resistance to multiple antibiotics in any microorganism (bacteria, fungal agents or parasites)" [8].

The main microorganisms responsible for causing hospital infection are *Staphylococcus* Coagulase-negative (15%), *Pseudomonas Aeruginosa* (15%), *Enterococcus* spp. (12%), *Candida* spp. (11%), *Escherichia coli* (10%), *Pseudomonas aeruginosa* (8%), *Klebsiella Pneumoniae* (6%), *Enterobacter* spp. (5%), *Acinetobacter baumannii* (3%) and *Klebsiella oxytoca* (2%). Among all hospital infections, 16% were associated with the use of polyantha microbials, such as methicillin-resistant *S. aureus* (8% of IH), *Enterococcus Faecium* Vancomycin-resistant (4%), *P. aeruginosa* carbapenem-resistant (2%), *K. pneumoniae* resistance to a broad-spectrum cephalosporin (1%), *Escherichia coli* resistant to broad-spectrum cephalosporins (0.5%) and *Acinetobacter baumannii, Klebsiella pneumoniae*, *Klebsiella oxytoca* and *Escherichia coli* carbapenem-resistant (0.5%) [9].

According to Shamweel (2009) [10], based on different studies, he concluded that infections caused by resistant bacteria are difficult to treat and the primary cause of an expressive number of morbidity, requiring strategies to minimize bacterial resistance such as the reduction in the number of antimicrobial prescriptions. However, they have not proved to be sufficient to combat the already established bacterial resistance. In this same study, it is stated that the adoption of shorter effective antibiotic treatment regimens is an effective strategy for reducing bacterial resistance, together with the restriction of the use of antibiotics with a high capacity for inducing bacterial resistance.

In view of the quantitative increase in Healthcare-associated infections (HCAI) s on the world stage, studies are needed that can contribute to Epidemiological Surveillance, making it relevant to observe and learn about the bacterial incidence and the profile of use of antimicrobials in the treatment of infections of patients treated at the Teaching Hospital of that work, so that adequate measures are taken to fight nosocomial infections.

Bacterial infections represent significant morbidity and mortality in the hospital environment and high health care costs, with the isolation of resistant strains in hospitalized patients becoming increasingly common. Based on this situation, this work is justified to contribute to the knowledge of academics and future health professionals regarding the profile of the antimicrobial used to fight hospital infections.

Multi-resistant reports from Jordan are rare and no information about the insulation and characterization of multi-resistant bacteria is available in the literature [11]. Shehabi., *et al*. (2000) [12] recorded that the ICU in Jordan University Hospital had 70% and 38% incidence of the development of ESBL in *Klebsiella Pneumoniae* and *Escherichia coli* isolates. The distribution of resistance is far from uniform even within the same region, despite the global utilization of antibiotics. Continuous monitoring is therefore needed in order to track antimicrobial susceptibility changes. For clinicians to make the choice of treatment, such knowledge is important. There is not very much detail on the gram-positive and gram-negative resistance trend in Jordan [13], however. Therefore, the retrospective analysis was performed to determine the rate of resistance from Princes Basma Teaching Hospital, Jordan between 2018 and 2019 to strained antibiotics extracted from cultures of various clinical specimens.

Materials and Methods

Current research is an epidemiological study with a descriptive cross-sectional and retrospective approach, due to its adequacy to the presented problem, including samples of inpatients from 2018 through 2019. This research was carried out in Princess Basma Teaching Hospital, Jordan. The collection of information was carried out through a survey of secondary data collected from the results of the tests available in spreadsheets of indicators existing in the Hospital Infection Control Service (HICs) of the hospital.

The diagnostic criterion for confirming hospital infection by the strains included in the study was isolation in cultures and its definition as a causal agent of the infectious process by the medical team.

The study included patients hospitalized with laboratory confirmation of hospital infection due to the isolation of the microorganism existing in clinical specimens, being excluded from the study patients of outpatient origin treated at that hospital. The information obtained in the course of this work will only be used to achieve the purpose foreseen for this research, assuming, in this way, the commitment to ensure their confidentiality.

Results and Discussion

248 positive culture results (Figure 1) from different topographic sites were analyzed 22 (9%) and 99 (40%) in January to December 2018, 71 (28.6%), and 56 (22.5%) in January to December 2019, respectively.

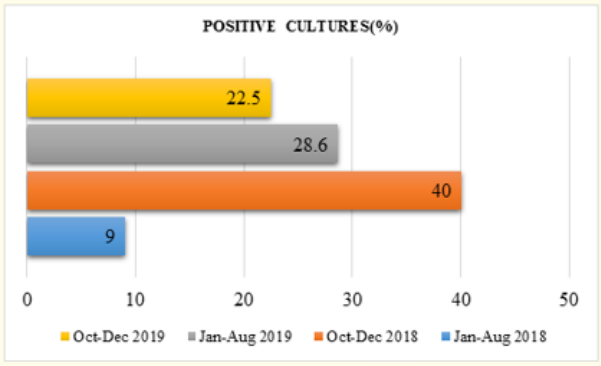

Figure 1: The quantitative of positive due to semi-infected infection related to health care in the period from 2018 to 2019 evolution of years dry weight.

Among the microorganisms isolated in the cultures during the period from 2018 to 2019 (Figure 2), the presence of Gram Positive Bacteria - GPB 62 (25.2%) was confirmed, which include the species of *Enterococcus faecalis, Enterococcus gallinarum, Pseudomonas aeruginosa, Staphylococcus epidermidis, Staphylococcus haemolyticus, Staphylococcus capitis, Staphylococcus warneri, Staphylococcus hominis, Streptococcus viridans, Streptococcus agalactiae and Streptococcus pneumoniae*; As for the isolation of Gram Negative Bacteria – GNB 179(72.5%), the species *Acinetobacter baumannii, Enterobacter aerogenes, Enterobacter cloacae, Escherichia coli, Klebsiella pneumoniae, Serratia marcescens*, *Serratia fonticola*, *Providencia stuartii*, *Proteus mirabilis*, *Pseudomonas aeruginosa, Pseudomonas putida, Morganella morganii*, *Stenotrophomonas maltophilia*, *Sphingomonas paucimobilis*; Yeast (Fungi) 7 (3%) were isolated, such as *Candida albicans* and non-albicans Candida.

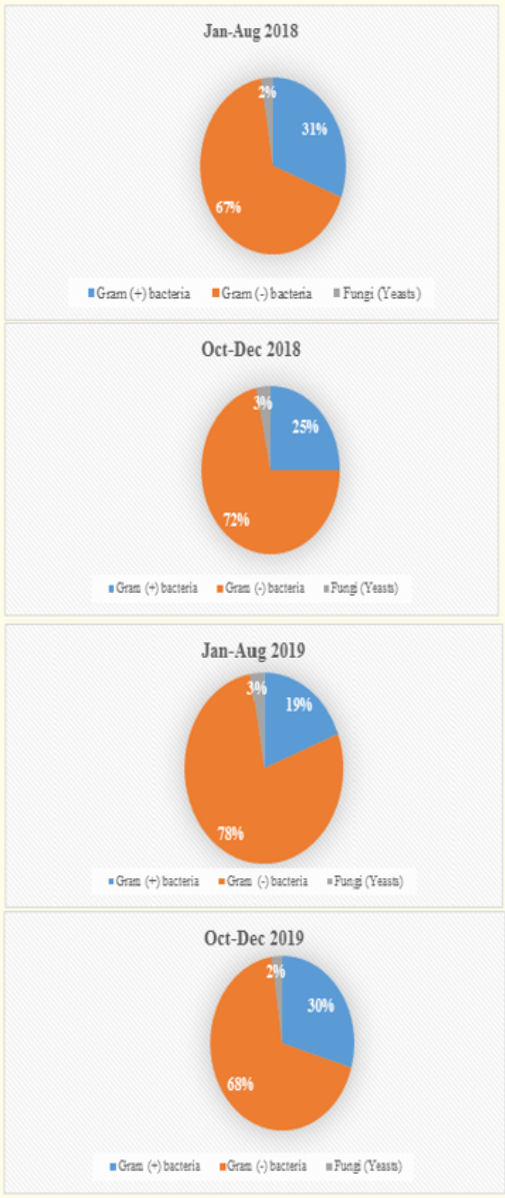

Figure 1: Quantitative of microorganisms isolated from positive culture of inpatients and their distribution during semester of the years 2018 and 2019.

Some bacteria isolated from microbiological cultures showed resistance mechanisms, and the following species can be mentioned: *Enterobacter cloacae* AmpC (1-September to December/2018), *Escherichia coli* ESBL (6-September to December/2018 and 2-September to December/2019), *Klebsiella pneumoniae* ESBL (13-September to December/2018 and 8-September to December/2019), *Klebsiella pneumoniae* KPC (1- September

to December/2019), *Proteus mirabilis* ESBL (2- September to December/2019), *Serratia marcescens* AmpC (3- September to December/2018), *Pseudomonas aeruginosa* MRSA (1- September to December/2019).

Among the Gram-Positive Bacteria with higher prevalence, the presence of the *Staphylococcus* genus, especially the species *Pseudomonas aeruginosa* (28 cases); In the group of non-fermenting Gram negative Bacteria, the species *Acinetobacter baumannii* prevailed (37 cases), from the group of Gram negative fermenters, the species *Escherichia coli* (23 cases) stood out, however in a study carried out in a public teaching hospital in Montes Claros/MG prevailed as GBP bacteria of the genus *Staphylococcus* (27 cases) out of a total of 112 isolated microorganisms, of these it was found that from the non-fermenting GNB the *Pseudomonas aeruginosa* species prevailed (12 cases), while from the fermenting GNB there was a prevalence of the species *Escherichia coli* with 23 cases [14]. Pereira., *et al*. (2016) [15] conducted a study at the Public University Hospital of Fortaleza/CE, and found that of the total of 692 cultures isolated from patients with infection, the microorganisms most frequently found were *Pseudomonas Aeruginosa* (18.3%), *Klebsiella Pneumoniae* (16.5%), *Acinetobacter Baumannii* (16.1%), *Pseudomonas aeruginosa* + *Staphylococcus* spp (13%), *Escherichia coli* (3.2%). In this study, fungi had 14% of the amount of isolated microorganisms, mostly of the genus Candida, with Candida albicans as the most isolated species. Gram negative microorganisms were more frequently isolated (81.1%) than Gram positive microorganisms (18.9%), corroborating our study, in which we obtain GNBs as the most prevalent (72%) and GPBs (25%) Franco., *et al*. (2018), when analysing a study at a University Hospital in Paraíba, found that out of 146 isolated microorganisms, the Gram negative species *Klebsiella pneumonia* was the bacterium that presented the highest number of isolation (34 cases - 23.3%), *Pseudomonas aerug*inosa (16%), *Escherichia coli* (13%), *Acinetobacter baumannii* (8.9%), *Pseudomonas Aeruginosa* (4.7%), *Proteus Mirabilis* (4.1%), in addition to other identified etiological agents that together add up to 11.8% [16].

Regarding the use of antimicrobials by hospitalized patients (Figure 3), during the January to August/2018 the most used in the treatment of patients were Cephalosporins 34.1% (22 cases), Quinolones 20.5% (13cases), Penicillin's 13.3% (9 cases), Carbapenems 10.8% (7), Glycopeptides 7.6% (5), Macrolides 3.7% (2), Aminoglycosides 3.7% (2), Polymyxin 2.9% (2), Lincosamides 1.9% (1) and Sulfas 1.9% (1); In the September to December/2018, the greatest use of antibiotics was in the Cephalosporin class 34.5% (25), followed by Quinolones 22.1% (16), Penicillin's 12.4% (9), Carbapenems 10.5% (8), Glycopeptides 10.2% (7), Macrolides 3% (2), Aminoglycosides 2.5% (2), Polymyxin 2.4% (2), Lincosamides 1.2% (1), Sulfas 1.2% (1).

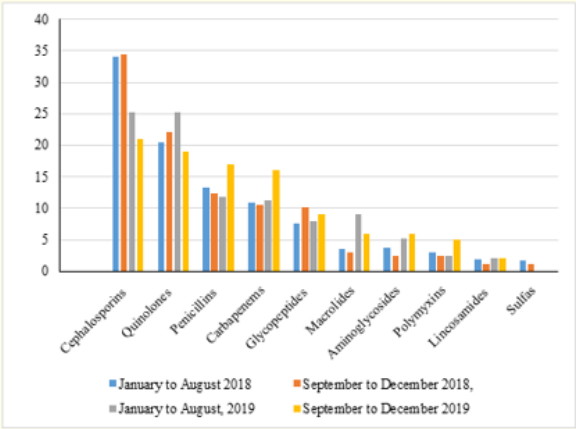

Figure 4: Quantitative number of patients who used antimicrobials during the semester of the years 2018 and 2019.

During the January to August/2019, patients used more Cephalosporins (25.3%) and Quinolones (25.3%) with 17 cases each, followed by Penicillin's 11.8% (8), Carbapenems 11.78% (8), Glycopeptides 8% (5), Macrolides 89% (6), Aminoglycosides 5.2% (3), Polymyxin 2.5% (2), Lincosamides 2% (1).

In the September to December 2019, more patients were used who used Cephalosporins (26 - 22.6%), followed by Quinolones (24 - 20.8%), Carbapenems (21 - 18.3%), Penicillin's 21% (10), Glycopeptides 18.9% (9), Lincosamides 17% (8) Macrolides 16% (7), Aminoglycosides 6% (3), Polymyxin 5% (2), in this period there were no cases of patients who used Sulfa drugs. In all the semesters studied, it was observed that antibiotics of the class of Monobactams and Tetracycline were not used to treat infections in patients.

In a study conducted by Wail., *et al*. (2015) [17], it was evidenced that anti-bacterial in the group of Glycopeptides were the most used (227 times), β-lactam and Penicillin's (133 times), Cephalosporins (38 times), Carbapenems (32 times), and other anti-bacterial (Polymyxin B, Colistin, Tigecycline, Vancomycin, Teicoplanin) reached a total of 378 times its use in the treatment of infections. In another study carried out in King Abdullah University Hospital,

Jordan by Jarab., *et al*. (2018) [18], highlight that among the use of antimicrobials used, Cephalosporins had the highest percentage (43.4%) corroborating with our research, followed by Penicillin's (16.3%), Fluoroquinolones (13%) and Aminoglycosides (9.7%), already in a study conducted by Niwa., *et al*. (2012) [19] in which they evaluated the profile of use of antimicrobials in adult patients in a hospital in Japanese university hospital, in the periods 2009 and 2010, observed that in the first year the most requested class were Cephalosporins (32%), Fluoroquinolones (26%), and broad spectrum Penicillin's (23%), but already in the second of the study Cephalosporins presented 28%, Penicillin's (26%) and Fluoroquinolones (25%), the latter result being compatible with our study, in which these classes of antimicrobials are presented in the quantitative order of use. In a study conducted by Al-Niemat., *et al.* (2014) [20], who investigated the pattern of prescription in the pediatric emergency department of a hospital in Jordan and observed that the prescription of antibiotics was quite frequent and that emergency doctors usually prescribe antibiotics for broad spectrum of action, the pathology being prevalent infections of the upper respiratory tract and that Macrolides, mainly Azithromycin, was the primary class among them.

Table 1 shows the distribution of Infections Related to Health Care (IRHC)-by topographic site; it is observed that in the September to December/2018 is the period that occurs the highest index of nosocomial infection with 72 cases, followed by the January to August/2019 (67), January to August/2018 (65) and September to December/2019 (46).

Period of collection/ Year →	**January to August 2018**		**Sept-Dec 2018**		**January to August 2019**		**Sept-Dec 2019**		**Total**	
Sample Source	**No of cultures**	**Percentage**	**No of cultures**	**Percentage**	**No of cultures**	**Percentage**	**No of cultures**	**Percentage**	**No of cultures**	**Percentage**
Respiratory	42	27.85	48	31.81	37	24.67	24	15.67	150	100
Gastrointestinal tract	1	16.17	3	35.97	2	30.51	1	17.35	8	100
Intra-abdominal	5	31.11	4	27.74	4	23.33	3	18.01	15	100
Urinary tract infection	4	20.50	4	20.40	5	31.31	5	28.02	17	100
Bloodstream Infection	4	26.16	2	15.58	4	33.03	4	25.01	14	100
Surgical infection Site	5	20.00	7	27.14	7	27.27	7	25.14	26	100
Osteoarticular	1	43.23	0	0.00	0	13.54	1	43.23	2	100
Skin and soft tissues	4	59.79	0	0.00	1	14.05	2	26.16	6	100
Other infections	1	1.21	1	49.04	1	27.07	1	22.67	1	100
Out-of-hospital	0	0.00	4	43.01	5	57.08	0	0.00	8	100
Total	65		72		67		46		248	

Table 1: Distribution of cases of hospitalized patients with hospital infection by Topographic Site, diagnosed in the period from 2018 to 2019.

According to this research carried out from 2018 to 2019, the topographic site that presented the highest infection rate in all semesters analyzed was the respiratory site, followed by infections related to the surgical site, with the exception of the September to December 2018, which is highlighted the "other infections" site.

In a study carried out in a public teaching hospital in Hashemite Kingdom of Jordan by Almaaytah., *et al*. (2015) [21], in a total of 225 cases of hospital infections notified, the analysis of the topographies showed the urinary tract infection (78 cases) as the most prevalent, followed by the site Respiratory (Pneumonia), with 72 cases, bloodstream infection with 22 cases. A research carried out in regional hospital in Hong Kong (Ng CK., *et al*. 2008) [22], with 234 notification forms of patients who presented Healthcare associated infections, found that 132 cases were due to respiratory infection, corroborating with our study in which it evidenced respiratory infection as the more prevalent, in that same study there were 36 cases of bloodstream-related infections and 34 cases of urinary-tract infections. In a study conducted by MacKenzie., *et al*. (2007) [23], the most prevalent topographies respiratory

infection (27.6%), urinary tract (26.4%) and surgical site (23.6%), bloodstream (11.9%), gastrointestinal tract (6.6%) and skin and parts soft (3.9%). It is observed that the topographies reported in the literature corroborate our study, but with different percentage rates.

The fact that the Medical Clinic sector has the highest rates of nosocomial infections is justified by having wards, in which patients are found who are affected by various pathological conditions, such as: Gastrointestinal, Hematological Diseases, Infect-contagious Diseases, etc., and for presenting the largest number of inpatients.

Conclusion

In view of what was described in this study, it was possible to demonstrate the use of various antimicrobials in the treatment of Healthcare-associated infections, leading to relevant discussions on the topic that can be conducted regarding the rational use of these drugs. As this study was carried out in a public teaching hospital, it was possible to arrive at adequate monitoring as to the indiscriminate use or not in these hospital environments, drugs taking into account the bacterial resistance factor.

A more detailed analysis of this study showed that groups of antimicrobials, such as cephalosporins, quinolones, and penicillin's were the most used; this is due to the high rate of bacterial resistance that several species of bacteria have been acquiring for several years. Therefore, there is an increasing trend in the greater use of certain broad-spectrum drugs. An important strategy to try to reduce this irrational use of some antimicrobial drugs is the holding by the SCIH of periodic meetings, where the epidemiological data that show on the bacterial incidence in the hospital environment, as well as the profile of antimicrobial susceptibilities, can be presented to the prescribers for that this information can serve as guiding instruments for empirical therapies, in addition to contributing to better control and determination of the number of drugs to be consumed in the treatment of Healthcare-associated infections, however, the professionals involved must realize that their participation in these meetings is essential to improve the control of IRHC. Here is a critical study that can contribute to further studies, as it establishes a relationship between the bacterial incidence in a hospital environment and the profile of antimicrobial consumption.

A careful analysis of the costs concerning the consumption of antimicrobial agents in the hospital environment is necessary, as it allows for an economic assessment to arrive at a rationalization of the drugs used, reflecting in a more efficient reduction of the impact on the hospital's finances.

Another consideration to be mentioned is that more studies of pharmacovigilance are still needed more and more since the drugs are useful in the treatment of various infectious diseases; however, their use in an inappropriate way allows a harmful effect on health.

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