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Research Article

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Antimicrobial Susceptibility Patterns: A Four Year (2017-2020) Surveillance Study at a Tertiary Acute Care Hospital in Saudi Arabia

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Abstract

Introduction

Objective

To analyze the antimicrobial susceptibility patterns in a four years period (2017-2020) at a tertiary acute care hospital in Kingdom of Saudi Arabia.

Methods *This is a retrospective observational study on a total 28214 pathogens isolated and shown in antibiograms between 2017 and 2020 at tertiary acute care King Salman Armed Forces Hospital Tabuk, Kingdom of Saudi Arabia.*

Results

The four-year (2017-2020) retrospective observational study analyzed antibiograms at King Salman Armed Forces Hospital Tabuk, Saudi Arabia . Among the six most common organisms isolated, Escherichia coli was the most prevalent Gram-negative species, and Staphylococcus aureus was the dominant Gram-positive species. The study revealed an upward trend in antimicrobial resistance, emphasizing the need for strict infection control measures and prudent antibiotic use to combat the rising resistance

Conclusion

There has been an upward trend in the development of antimicrobial resistant organisms as observed in our study which is in agreement with other local studies showing same trends

1. Introduction

Whereas there has been lot of morbidity and mortality due to infectious diseases in pre-antibiotic era, there is now a decline in the effectiveness of antibiotics and ever since development of resistance [1]. Antimicrobial resistance is increasing, and there are several contributing factors. Antibiotic resistance is a global problem. Besides natural mutations there are certain preventable reasons of antibiotic resistance development [2]. The regions and institutions with less resources, lack of guidelines ,reckless use of antibiotics without antibiotic stewardship programs, are facing higher failure of antibiotic therapies [3].Thus poor case managements, improper dosage and combinations has led to antibiotic resistance and development of multidrug resistant pathogens [4]. As a result there is increased morbidity, mortality on one hand and on the other hand there is increased burden of cost on the health system [5]. Antibiograms help to gauge the pattern of susceptibility and trends of antimicrobial resistance (AMR) and thus help to adopt measures to counter this problem [6]. Objective of this retrospective observational study is to analyze the antibiograms during four years period (2017-2020) at King Salman Armed Forces Hospital Tabuk, Kingdom of Saudi Arabia, a 500 hundred bedded tertiary care multi-specialty health facility.

1.1 Inclusion & Exclusion Criteria Out of total (n=28214) organisms isolated in four years (2017-2020), the six most common type of organisms(n=17973) were included Figure:1- bar graphs, while least common organisms(n=10214) were excluded.

2. Materials and Methods

2.1 Samples

This four year (2017-2020) retrospective observational study was conducted to analyze the susceptibility and antimicrobial resistance patterns of isolates irrespective of specimen source as reported in the annual hospital antibiograms.

Six most common pathogens of the total organisms isolated were studied for their number, type and sensitivity resistance patterns while excluding the least common organisms.

2.2 Methods

An automated platform with an expansive database, the VITEK® 2 microbial Identification/Antimicrobial Sensitivity testing system was used (biomatrix. Marcy l'Etoile, France). The Vitek 2 (AES software) Gram-Negative Identification test (GNI) card or Gram-Positive Identification test (GPI) cards were used to identify the bacteria. AST-N291 (Gram negative), AST-292 (Gram negative), AST-XN20 (Gram negative), and GPS67 (Staphylococcus/ Enterococcus) or AST-ST03 (Streptococci beta-hemolytic/ viridians/ pneumococci) sensitivity cards, were used to determine antibiotic sensitivities accordingly. Cards were inoculated with the suspension vials at the Smart Carrier Station™ and loaded into the Vitek 2 automated reader-incubator. The isolates suspensions were adjusted to a 0.5 McFarland standard for identification and susceptibility tests. The Identification and susceptibility cards were inoculated and interpreted according to the manufacturer's instructions. Quality control strains, including Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 27853, Staphylococcus aureus ATCC 25923 and Enterococcus faecalis (ATCC92120) were used. Results were interpreted as Sensitive (S), Intermediate (I) and Resistant (R) for the sensitivity testing, according to the Clinical and Laboratory Standards Institute (CLSI) recommendations.

3. Data Analysis

All identification and sensitivity data were extracted from the Vitek-2 machine and converted into an excel spread sheet for statistical analysis in order to generate the hospital antibiogram. Results were expressed as percentage Sensitive (S) for the antibiotics tested according to the CLSI recommendations.

4. Discussion

Worldwide literature on antimicrobial susceptibility patterns shows that there is increased antimicrobial resistance (AMR) and this issue has equally affected animals and human beings [7]. There has been lot of morbidity and mortality in pre-antibiotic era. Discovery of antibiotics like penicillin helped a lot to curb bacterial infections but since then emerging antimicrobial resistance has put a huge challenge in treating bacterial infections [8]. It is imperative to keep surveillance on the efficacy of available antibiotics and to see degree of resistance development. On one hand it motivates pharmaceuticals for new research and on the other hand guides clinicians to choose appropriate antibiotics for better case management.

Number of total isolates during these four years from various samples like blood, urine, sputum, body fluids and wounds was 28214(n=28214). The commonest six organisms isolated (n=17973) were included in our study while less common 10241(n=10241) were excluded. Among the six commonest organisms (n=17973), Gram negative constituted 83% (n=14197), while 21% (n=3776) were Gram positive. Figure:1-bar Graphs. Escherichia coli (E.coli) was the commonest Gram negative organism in all fours years(2017-2020),followed by Klebsiella Pneumoniae, Pseudomonas aeruginosa and Acinetobacter baumannii.

Staphylococcus aureus and Coagulase negative Staphylococcus were the commonest Gram-positive organisms throughout four years studied Figure:1-bar graphs. E. coli constituted 49.86% in 2017,25.45% in 2018,32.55% in 2019 and 36% in 2020. Klebsiella Pneumonia contributed 28% in 2017,15% in 2018,22.47% in 2019 and 28% in 2020 .Third commonest Gram negative organism after E.coli and Klebsiella Pneumonia was Pseudomonas Aeruginosa with the tune of 28% in 2017,12.56% in 2018,14.44% in 2019 and 26.63% in 2020 .Contrary to another acute care hospital in Saudi Arabia where ,Streptococcus pneumoniae was reported ranging from 10-23.4%, in our study it has been the least common organism 4%, and thus excluded [9]. while a figure of 1.79% has been reported from a rehabilitation setting in Saudi Arabia [10].

There has been linear down ward trend in the number of E.coli till 2019 as hospital adopted strict hand hygiene practices and wearing of Personal Protective Equipment (PPE) was strictly observed Figure:2- line graphs. But later on there has been a rising trend till 2020 Figure:2-line graphs. One reason could be increased number of admissions of geriatric patients, having stroke , bed bound patients requiring relatively longer hospital stay. Majority of these patients were having neurological issues like swallowing problems on nasogastric tube diet (NGT)hence recurrent aspiration pneumonias.Those having neurogenic bladders with indwelling foleys catheters complicated with recurrent urinary tract infections (UTI) caused by E. coli and Klebsiella pneumoniae besides having hospital acquired pressure ulcers (HAPU) Figure:2-line graphs. Similar high rate of urinary tract and skin infections caused by E. coli and staphylococcus aureus has been observed in a rehabilitation setting in Saudi Arabia [10].

As regards sensitivity patterns Tables 1,2,3,4 among Gram negative isolates, most affective antibiotics on E. coli included Colistin (98%), Meropenem (98%) Tigecycline (97%). Whereas Klebsiella Pneumoniae was seen less sensitive to Colistin (87%),Amikacin (76%),Tigecycline (78%)and Meropenem (72%) showing high development of multidrug resistance).Various studies in Saudi Arabia Saudi has shown almost similar trends. Pseudomonas aeruginosa was seen as the 3rd commonest organism isolated and sensitive to colistin (87%), amikacin (70%), levofloxacin (67%), ceftazidime (64%).A high quinolines resistance was observed in our study and similar trends has been reported in other studies from Saudi Arabia [11,12]. In general increased antimicrobial resistance was observed against quinolines and carbapenems. A systemic review of MDR in Gram negative bacilli (GNB) showed a substantial rise in rate of carbapenem resistance in Saudi Arabia [13]. Similar trends are reported from various regions of Saudi Arabia in a national survey [14]. There has been relatively a steady state as regards Klebsiella Pneumoniae throughout the study period but during 2019-2020, but later an upward trend was noticed in extended spectrum beta-lactamase positive (ESBL-positive) Klebsiella pneumoniae multidrug resistant (MDR) species in urine, blood and respiratory secretions. The rate of sensitivity for Klebsiella Pneumoniae to various antibiotics recorded was, colistin 90%, Amikacin 86%, tigecycline 79% and meropenem70% respectively. Third most common gram-negative organism was Pseudomonas aeruginosa and was showing reduced sensitivity to colistin in 87%, amikacin 70%, levofloxacin 65%, ceftazidime 60%, ciprofloxacin 56% and tazocin 55%. Thus, a significant multidrug resistance especially to quinolines was noted here as well. On the whole a similar pattern of susceptibility was observed throughout the studies period irrespective of the numbers. Our findings are comparable to various studies done in side Saudi Arabia and gulf states [15,16,17,18,19]. During the year 2017,Staphylococcus aureus and Staphylococcus Coagulase negative remained the commonest Gram-positive organisms constituting 18.92% and 14.67% respectively, but their frequency in 2018 was comparable each being 10.55%.In the year 2019,frequency of Staphylococcus aureus and Staphylococcus coagulase negative reported was 12.17% each. During the year 2020 they ranked 18.92% and 14.67% respectively as shown in Tables:1,2,3,4. Sensitivity trends for Gram positive organisms are shown in Figure 2-line graphs.

As regards sensitivity patterns of Gram-positive organisms during 2017&2018, no significant change was observed in antibiotic resistance including MRSA (methicillin resistant staphylococcus aureus). However, there was increased vancomycin resistance (VRE)observed against Enterococcus faecalis speciesFigure 2:line graphs. Many other reports from other local studies have shown similar trends in case of VRE, but this is of little epidemiological relevance than MRSA [20,21,22]. Similarly increased resistance was observed as regards carbapenems used for Acinetobacter baumannii species. The most affective antibiotics against Staphylococcus aureus were oxacillin (100%), linezolid (100%), vancomycin (100%) Clindamycin (94%).

After general review of the antibiograms during years 2017&2018 which showed upward trends in overall antimicrobial resistance ,the local stewardship committee recommended use of piperacillin/tazobactam and discouraged the use of carbapenems especially in hospital acquired infections with Pseudomonas aeruginosa. Carbapenem resistance was noticed on the rise against Klebsiella pneumoniae and Acinetobacter baumannii species Figure-2-line graphs. The drug of choice for the treatment of oxacillin sensitive Staphylococcus aureus was flucloxacillin IV or Cefazolin IV as they have shown better outcomes in our study than vancomycin. Hence beta -lactams still retain their merit as a first choice for surgical prophylaxis till to-date. The antibiotic steward team recommended use of clindamycin in those patients allergic to penicillin, while for MRSA (methicillin resistant staphylococcus aureus) drug of choice advocated was vancomycin or teicoplanin (preferred in those having renal insufficiency).The sensitivity patterns seen with vancomycin and linezolid were identical, therefore vancomycin is recommended to be preferred over linezolid by our local antibiotic steward team.

Culture & sensitivity remains the gold standard for bacterial isolates from clinical specimens and hence yearly local antibiograms help to choose suitable antibiotics for better case management. Antibiograms during year 2019 & 2020 revealed Klebsiella pneumoniae spp as the most resistant organism showing low sensitivity to piperacillin/tazobactam by 29%, amikacin 15%, imipenem 10%, meropenem 12%, levofloxacin 22%, ciprofloxacin 30%, tigecycline 15% and colistin 16% respectively. Similarly, Escherichia coli were seen having increased resistant to levofloxacin (7%), ciprofloxacin (8%).

Increased resistance to aminoglycosides has been observed in Acinetobacter baumannii and Porteous mirabilis species Figure-2:line graphs.Treating MDR-Klebsiella Pneumoniae more frequently with meropenem, has led to increased resistance against meropenem as compared to imipenem. Therefore, advice by the infectious diseases' consultant was made compulsory by the hospital stewardship committee. A significant overall down ward trend during early 2019 was observed in number of isolates, because of strict implementation of infection control measures like hand hygiene and use of sensitizer before touching any patient. Figure:2-line-graphs. But onwards in the late 2019 and year 2020 ,the number of isolates mainly from blood, urine, wounds and respiratory secretions showed an upward trend as shown in Figure:2-line graphs. Emergence of Porteous mirabilis reported during year 2020 from urine samples (n=195) also represented increased incidence of urinary tract infections in long stay patients having strokes and neurological bladder necessitating indwelling foleys catheter or condom catheter including diapers. It does not mean necessarily an increase in rate of infections, because it includes colonization as well. Another contributing factor during this period was increased number of old age long staying patients after opening progressive care unit in our hospital and that is the reason our results during this period are in agreement reported from a rehabilitation setting in Riayadh Saudi Arabia and another one from Al-Jouf Saudi Arabia [23].

Acinetobacter baumannii spp and Klebsiella pneumoniae spp (ESBLs) continues to be the most resistant organisms to Carbapenem showing significant decreased sensitivity of 44% (carbapenems) and 45% (ESBLs) respectively. Similar observations has been reported in other centers in Saudi Arabia except Makka region where there has been very high antimicrobial resistance to MDR Acinetobacter baumannii , E.coli and Klebsiella pneumonia due to large number of pilgrims from all over the world visiting the Kingdom. Almost similar reports has been from other acute care hospitals in K.S.A [24,25,26,27.28]. Resistance patterns reported in Gram negative isolates during year 2020 followed a similar trend as observed during the previous year 2019. Similar trends have been reported in other local studies in Saudi Arabia [30,31].

5. Conclusion

Antibiogram is a guide to empiric therapy based on antimicrobial resistance and sensitivity patterns in a health care setting .Culture sensitivity is the gold standard for bacterial isolates from clinical specimens and antibiograms is not a substitute for culture & sensitivity .There has been an upward trend in the development of antimicrobial resistant organisms as observed in our study which is in agreement with other local studies in Saudi Arabia and in Gulf region.Therefore hospital has to continue restriction in the prescription of vancomycin, carbapenems, tigecyclines, colistin, linezolid and quinolines group, which should be prescribed in consultation with the infectious disease consultant or clinical pharmacist (member of the stewardship committee). Cohorting strategy of long stay patients in separate dedicated places could prevent cross infection. A comprehensive hospital acquired pressure ulcers (HAPU) preventive program could reduce skin ulcers and thus prevent skin infections in long stay patients. Continuous monitoring of yearly local trends of antimicrobial resistance and susceptibility patterns besides strict adherence to infection prevention control measures are essential. Besides other patient safety measures like aseptic procedures, proper hand hygiene is the single most important factor to eliminate spread of infection. Country wide ban on sale of antibiotics without prescription,an education campaign on electronic and print media advocating judicious use of antibiotics could raise awareness among the people.

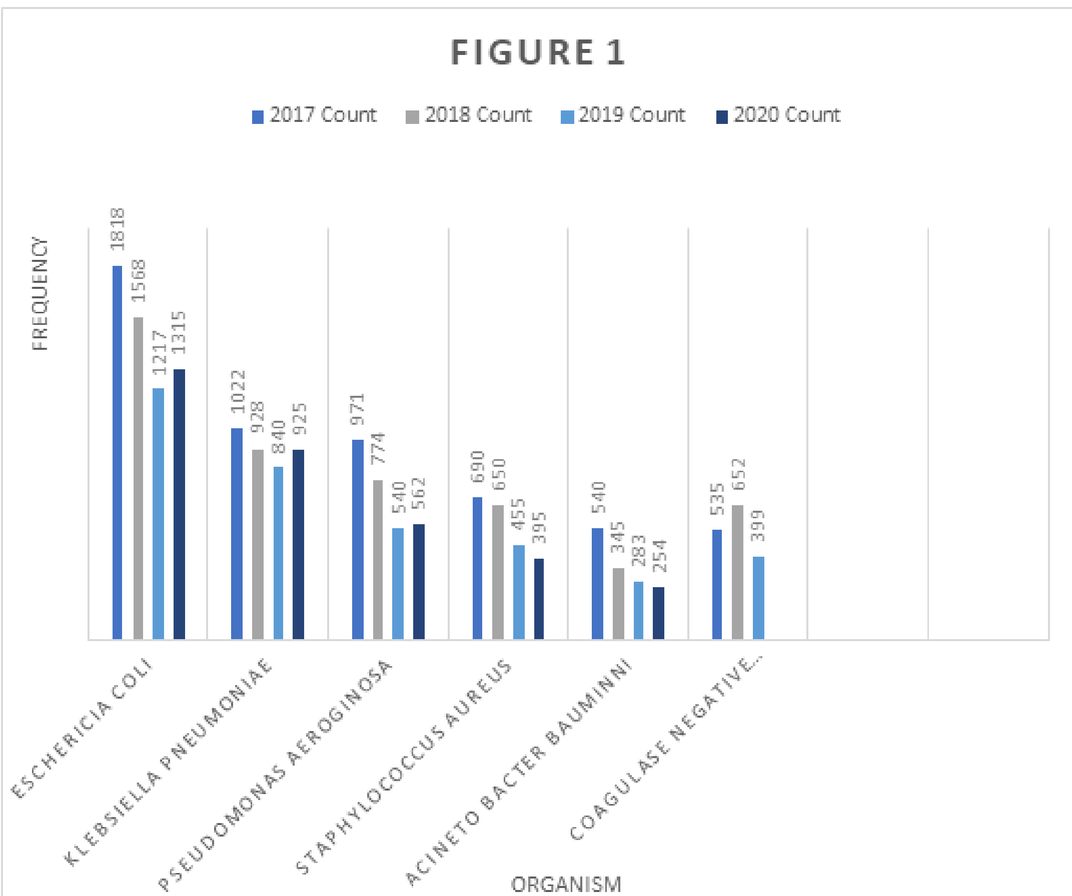

Figure 1: Frequency of 6 Commonest Organisms (n=17973) Isolated During (2017 – 2020)

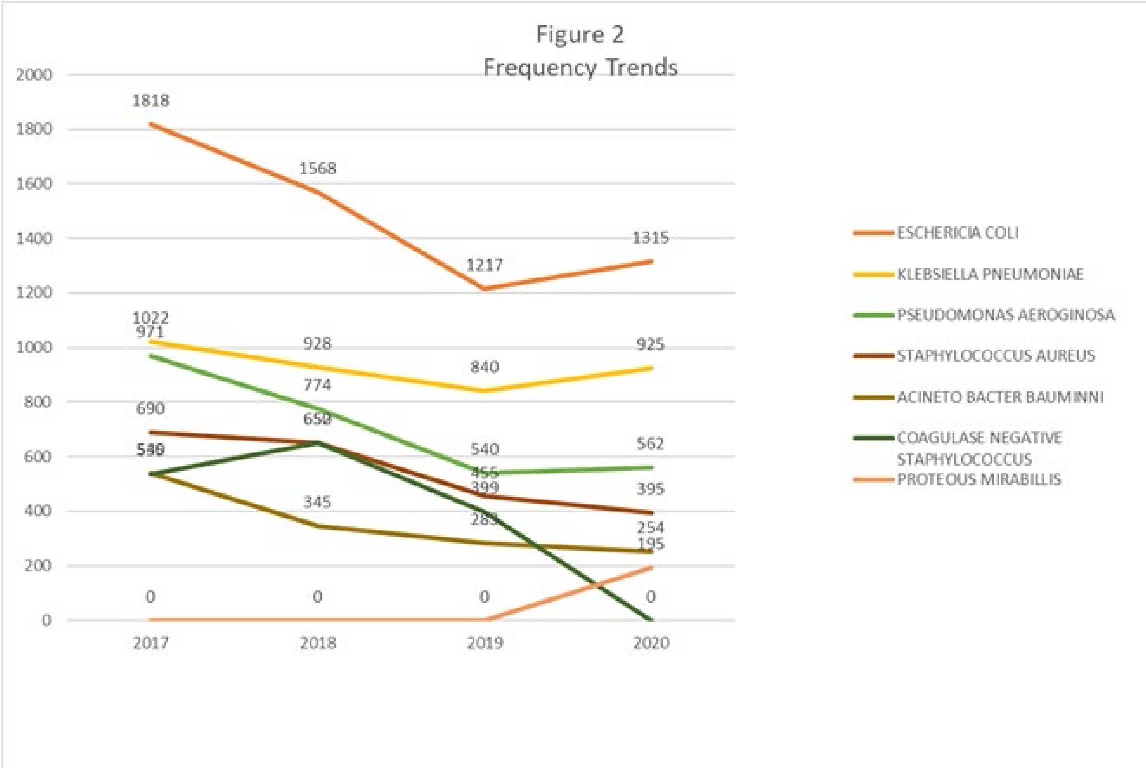

Figure 2: Frequency and Trends of 6 Commonest Organisms (n=17973) During (2017 – 2020)

Organisms number (n)	Organism %	Drug susceptibility
1818	Eschherecia coli 49.86%	Meropenem 98%, Imipenem98%, Amikacin 94%, Gentacin 81%, Tazocin (Piperacillin + Tazobactam) 81%
1022	Klebsiella Pneumoniae 28%	Colistin 90%, Amikacin 86%, Tigecycline 79%, Meropenem 70% --Mdr Observed.
971	Pseudomonas aeriginosa 26.63%	Collistin 87%, Amikacin 70%, Levofloxacin 65%, Ceftazidime 60%, Ciprofloxacin 56%, Tazocin 55%, (MDR & Quinoline Resistance Observed).
690	Staphylococcus aureus 18.92%	Oxacilin100%, Linezolid100%, Vancomycin 100%, Amoxicillin + Clavulanic acid 91%, Clindamycin 94%
540	Acinatobacter bauminnii 14.81%	Colistin 85%, Tigecycline 75%, MDR-Observed (Gentacin, Amikacin, Meropenem, Quinolines, Ceftazidime).
535	Coagulase negative Staphylococcus 14.67%	Linezolid 100%, Vancomycin 100%, Teicoplanin 100%, Clindamycin 70%, Cefazoline 13%--(need to look for other surgical prophylaxis).

Table 1: Six Commonest Organisms Isolated -2017 (n=5576) & Drug Sensitivity Patterns.

Tables 1,2,3 & 4 Showing Annual Susceptibility Patterns of the Six Commonest Organisms During (2017 – 2020)

Organisms number (n)	Organism %	Drug susceptibility
1568	Eschericia coli 25.45%	Colistin 98%, Amikacin98%, Tigecycline 97%, Meropenem 98% {Quinoline Resistance Observed}.
928	Klebsiella pneumoniae 15%	Colistin 89%, Amikacin 76%, Tigecycline 78%, Meropenem 72% --MDR Observed.

774	Pseudomonas aeriginosa 12.56%	Colistin 87%, Amikacin 70%, Levofloxacin 67%, Ciprofloxacin 53%, Ceftazidime 64%-- Tazocin 63%, (Quinoline Resistance Observed) .
652	Coagulase negative Staphylococcus aureus 10.55%	Linezolid 100%, Vancomycin 100%, Teicoplanin 100% Clindamycin 67%, Erythrosine 74%, Oxacillin 19%--{Need To Look For Other Surgical Prophylaxis Than First Generation Beta lactam }.
650	Staphylococcus aureus 10.55%	Oxacillin 100%, Linezolid 100%, Vancomycin 100%, Amoxicillin+Clavulanicacid91%, Clindamycin 94%
345	Acinobacter bauminnii 5.60%	Colistin 87%, Tigecycline 85%, MDR (Gentacin, Amikacin, Meropenem, Quinolines, Ceftazidime).

Table 2: Six, Commonest Organisms Isolated-2018 {n=4917} & Sensitivity Patterns

Organisms number(n)	Organism %	Drug Susceptibility
1217	Eschericia coli 32.55%	Colistin 98%, Amikacin 98%, Tigecycline 97% , Meropenem 98% (Quinoline Resistance Observed).
840	Klebsiella pneumoniae 22.47%	Colistin 87%, Amikacin 70%, Levofloxacin 67%, Ciprofloxacin 53%, Ceftazidime 64%-- Tazocin 63%, (Quinoline Resistance Observed).
540	Pseudomonas aeriginosa 14.44%	Colistin 87%, Amikacin 70%, Levofloxacin 67%, Ciprofloxacin 53%, Ceftazidime 64%-- Tazocin 63%, Levofloxacin 58%, Ciprofloxacin 52% (Quinoline Resistance Observed).
455	Staphylococcus aureus 12.17%	Oxacillin 100%, Linezolid 100%, Vancomycin,100%, Doxycycline 88%, Moxifloxacin 95%, Clindamycin 88%
399	Coagulase negative staphylococcus 10.67%	Linezolid 100%, Vancomycin 100%, Teicoplanin 100% Clindamycin 65 %, Erythromycin 35%, Oxacillin 19%--(Need To Look For Other Surgical Prophylaxis Than First Generation Beta lactam).
283	Acinatobacter bauminnii 7.57%	Colistin 92%, Tigecycline 85%, MDR (Gentacin, Amikacin, Meropenem, Quinolines, Ceftazidime).

Table 3: Six, Commonest Organisms Isolated -2019 (n=3734) & Sensitivity Patterns.

Organisms number(n)	Organism %	Drug Susceptibility
1315	Eschericia coli 36%	Colistin 98%, Amikacin 98%, Tigecycline 99%, Meropenem 98% Gentacin 88%, Amikacin 94%, (Quinoline Resistance Observed).
925	Klebsiella pneumoniae 25.37%	Amikacin 65%, Tigecycline65%, Meropenem 58%, Levofloxacin 67%, Ciprofloxacin 53%, Ceftazidime 50%, Tazocin 55%, (MDR & Quinoline resistance Observed).
562	Pseudomonas aeriginosa 15.41%	Colistin 87%, Amikacin 70%, Levofloxacin 67%, Ciprofloxacin 53%, Ceftazidime 61% -- Tazocin 45%, (Quinoline Resistance Observed).
395	Staphylococcus aureus 10.83%	Oxacillin 100%, Linezolid 100%, Vancomycin 100 %, Amoxicillin + Clavulanic acid 91%, Clindamycin 94%
254	Acinatobacter bauminnii 7%	Colistin 87%, Tigecycline 79%, MDR (Geneticin 48%, Amikacin 58% Meropenem 19%, Quinolines 14,15 High Resistance, Ceftazidime 15%).
195	Proteus mirabillus 5.34%	Meropenem 96%, Tazocin 96%, Cefepime 80%, Amikacin 74%, Ceftazidime 73%, Gentacin 0%

Table 4: Six Commonest Organisms Isolated -2020 (n=3646) & Sensitivity Patterns.

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