Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

CULTURE AND ANTIMICROBIAL SENSITIVITY PATTERNS IN DIABETIC FOOT ULCER PATIENTS PRESENTING TO MARDAN MEDICAL COMPLEX, MARDAN, KHYBER PAKHTUNKHWA, PAKISTAN

Muhammad Yasir[1], Noor Ali Shah[2], Muhammad Ayaz [3], Muhammad Anwar[4], Ubaid Ullah[5], Sajid Ali[6], Irfan Ullah[7]

[1]*Lecturer at IHS School of Pharmacy, Ring road, Mardan*
[*2]*RNO, DHQ Hospital Mardan*
[3] *Principal, BS-MLT program, Institute of Health Sciences, Mardan*
[4,7]*Pharmacist*
[5]*Lecturer, BS-MLT program, Institute of Health Sciences, Mardan*
[6]*Pharmacology Lecturer, East West Medical Institute Mardan KP Pakistan*

[1]yasirkh956@gmail.com, [*2]nooralishah1688@gmail.com, [3]muhammadayazscholar@gmail.com, [4]m.anwar.rph@gmail.com, [5]ubaidullahtahirm@gmail.com, [6]sajidali100222@gmail.com, [7]irfanullahtangi123@gmail.com

DOI:https://doi.org/10.5281/zenodo.20772913

Keywords
Diabetic Foot Ulcer, Culture and Sensitivity, Staphylococcus aureus, Antimicrobial Resistance, Mardan.

Article History
Received: 21 April 2026
Accepted: 03 June 2026
Published: 20 June 2026

Copyright @Author
Corresponding Author: *
Muhammad Yasir.

Abstract

Background: *The identification of common pathogens and their corresponding antimicrobial susceptibility patterns is critical for the effective clinical management of diabetic foot ulcers (DFUs). Presenting these microbiological and demographic datasets through structured analytical tools aids clinical decision-making and helps optimize targeted healthcare interventions globally. This study aimed to isolate the highly prevalent causative bacterial pathogens involved in diabetic foot infections at the Mardan Medical Complex Teaching Hospital (MMCTH) and to map out their respective antibiotic sensitivity and resistance profiles using SPSS version 16.0.*

Methods: *A descriptive, cross-sectional analysis was performed on a cohort of 104 patients presenting with active DFUs to the surgical department. Pus swab specimens were aseptically collected from ulcer sites for microbiological isolation, culture characterization, and phenotypic antimicrobial susceptibility testing using standard laboratory protocols.*

Results: *Out of the 104 clinical presentations, 81 cases (77.88%) yielded positive bacterial cultures, while 23 specimens (22.12%) demonstrated no growth. Demographic analysis revealed a higher prevalence of DFUs among male patients (57.69%) compared to female patients (42.31%). Systemic stratification indicated a massive predominance of infections among individuals with Type 2 Diabetes Mellitus (84%) compared to Type 1 Diabetes Mellitus (16%), with the 52–62 age cohort emerging as the most heavily affected group in the study area. Staphylococcus aureus was identified as the single most dominant isolated pathogen, accounting for 46.91% of positive cultures. Vancomycin demonstrated the highest therapeutic sensitivity against Gram-positive isolates (69.23%), whereas Amikacin and Piperacillin/Tazobactam proved to be the most effective agents against the isolated Gram-negative spectrum.*

Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Conclusion: *Microbial sensitivity profiles across different classes of antibiotics in the target region remain highly variable and uneven. An unhygienic lifestyle, carelessness regarding basic foot hygiene, an absence of routine clinical follow-ups, and a general lack of awareness regarding secondary metabolic complications serve as the primary driving risk factors behind severe DFU development in this region. These findings highlight the critical need for routine culture-guided treatments to mitigate the rise of multi-drug resistant strains.*

1. INTRODUCTION

Diabetic foot ulcer (DFU) is a serious and common complication of diabetes mellitus (DM) that significantly increases the cost of treatment.

Among persons with diabetes (PWD), approximately 12%–25% face the risk of developing a foot ulcer during their lifetime.[1]

The most common cause of morbidity and mortality in DFU is infections, which are seen in 40%–80% of the cases.[2]

Diabetic neuropathy and micro- or macro-ischemia are the two main risk factors that cause DFU.[3]

Impaired microvascular circulation limits the access of phagocytic cells to infected area, and this results in poor concentration of antibiotics in infected tissue.[4]

Hence, diabetic foot wounds are commonly infected, and hence infection leads to the formation of microthrombi causing further ischemia, necrosis, and progressive gangrene. These types of situations necessitate limb amputation. Thus, accurate diagnosis of the causative organism is essential for the management of these cases. The burden of diabetes is rising rapidly, particularly in South Asia. Pakistan stands at number 6 among the top ten countries with an increasing burden of DM. PWD has a 10-fold higher chance of hospitalization due to soft tissue and bone infection when compared with the nondiabetic individuals.[5]

The blood supply to the lower extremities is further compromised by local injuries and inadequate foot care.[6]

Diabetic neuropathy leads to repeated non recognized trauma to the insensate feet and this causes callosities, cracks, fissures, and ulcer formation. Secondary infection of the ulcer with arterial abnormalities further complicates the condition leading to gangrene and limb loss. A compromised immune state in PWD favors rapid and relentless development of local sepsis and even life-threatening septicemia. Massive infection is the most common factor leading to limb amputation.

DFUs are chronic in nature and patients with DFUs usually require several episodes of hospitalization. PWD are often exposed to several antibiotics which increase their risk of developing multidrug-resistant infection. Mostly, the diabetic foot infections (DFIs) are mixed bacterial infections, and the proper management of these infections requires an appropriate antibiotic selection, based on the culture and the antimicrobial susceptibility testing results.[7]

Because DFU is frequently chronic and well-contaminated with a number of microorganisms, it is very important to properly obtain and process the specimens from infected wounds in order to identify the true pathogens and their antimicrobial susceptibilities and, thus, select an appropriate antimicrobial therapy. Staphylococcus aureus and Pseudomonas aeruginosa are important causative microorganisms in DFIs. The distributions of these causative organisms differ geographically and according to the illness duration, prior antibiotic use, and the relevance of nosocomial infections.[8] Recently, the use of inappropriate antibiotics has become a problem for multi-drug resistant bacteria, making the selection of antibiotics difficult.[9]

Current guidelines for the management of adults with hospital-acquired, ventilator-associated and healthcare-associated pneumonia issued jointly by the American Thoracic Society and the Infectious Diseases Society of America (IDSA) recommend

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

either linezolid or vancomycin as appropriate antibiotic agents for the treatment of MRSA nosocomial pneumonia (NP).[10]

The guidelines do not, however, address the potential for worse outcomes of this infection in a patient with diabetes, nor how the presence of this comorbidity might affect selection of antibiotic therapy. Presumably, this is based on a lack of published data on these issues.

Our study is focused on the causative agents involved in diabetic foot and also to study the sensitivity and resistance of different organisms to different antibiotics.

Aims and Objectives

1. To determine highly prevalent agents involved in DFU patients in MMMCTH.
2. To identify the most common susceptible and resistive antibiotics groups.

Need of the Project:

Diabetes Mellitus (DM), a metabolic disorder, is emerging as an epidemic worldwide. Which if not properly managed can lead to long term life threatening complications and premature deaths. Moreover the cost involved in management of this disease and its complication is quite high particularly in developing countries, because there is 170% increase in the incidence of DM, as compare to 47% in developed countries, Reasons are population growth, aging, urbanization, increased prevalence of obesity and physical inactivity. Pakistan stands on number 6 among the top ten countries having increase burden of DM.

According to the current statistics of the international Diabetes federation (IDF), it has been projected that approximately 1 in 11 adults (415 million) has diabetes and is expected to reach 1 in 10 adults (642 million) up to 2040.

Among diabetic patients 12% to 25% have a risk of developing a foot ulcer during their lifetime. The most common cause of morbidity and mortality in these patients is infection which can see in 78% of the cases. The main aim of the project is the accurate diagnoses of the causative organisms because these patients have a 10 fold higher chance of hospitalization as compare to non-diabetic. Mostly the diabetic foot infection require an appropriate antibiotic selection based on the culture and the antimicrobial susceptibility testing results. This research will highlight all these problems in the research area.

2. LITERATURE REVIEW:

Diabetic foot infections (DFI) cause significant health problems, reduce the patients' quality of life, cause lower limb amputation, increase morbidity, and increase the cost of health services.[11]

DFI frequently require hospitalization of patients, and could lead to death. Lavery et al. reported that the risk of hospitalization among the patients with DFI was 56 times and the risk of amputation was 155 times higher than non-diabetics.[12]

DFIs arise mainly from skin ulceration associated with loss of protective sensation (peripheral neuropathy), altered foot architecture, and some forms of trauma.[13] Various types of microorganisms colonize and proliferate on the wounds, which serve as a point of entry, causing tissue damage and resulting in an inflammatory response that is characterized as a clinical infection. These infections can spread contiguously to deep tissues and cause osteomyelitis if they reach bones.[14]

Some degree of peripheral arterial disease (PAD) is present in most patients with DFIs and ischemia can lead to necrosis and further failure of the integrity of the surrounding tissue. DFIs together with PAD is a significant predictive factor for LEA.[15]

Because DFU is frequently chronic and well-contaminated with a number of microorganisms, it is very important to properly obtain and process the specimens from infected wounds in order to identify the true pathogens and their antimicrobial susceptibilities and, thus, select an appropriate antimicrobial therapy. Staphylococcus aureus and Pseudomonas aeruginosa are important causative microorganisms in DFIs. The distributions of these causative organisms differ geographically and according to the illness duration, prior antibiotic use, and the relevance

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

of nosocomial infections.[16] Recently, the use of inappropriate antibiotics has become a problem for multi-drug resistant bacteria, making the selection of antibiotics difficult.[17]

In the literature, prevalence for diabetic foot ulcers is reported from 4% to 10% in diabetic patients worldwide; of that percentage, between 60% and 80% of the cases are resolved, while between 5% and 24% end in the amputation of the limb. In South and Central America, this indicator is between 5% and 20%, however; although the exact data of the diabetic foot epidemiology have not been documented, the high prevalence of the disease causes a greater risk of developing foot ulcers.[18]

the prevalence of diabetic foot change according to age, gender and place of origin from 2.4% to 5.6%.[19]

In the case of diabetic foot ulcers generated by pressure and vascular origin, in which the balance of the growth factors in the tissues has been lost, therefore, the recombinant factor that stimulates the proliferation and migration of epithelial cells generates a closing of the chronic wound more quickly.[20]

Given the above, its use in patients with diabetic foot ulcers has shown that it can prevent associated complications such as infection and amputations by up to 70%.[21]

The key to management of diabetic foot wounds is prevention. The lifetime risk of developing a foot ulcer is 15%, while in diabetics, the incidence of developing an ulcer may be as high as 25%.[22]

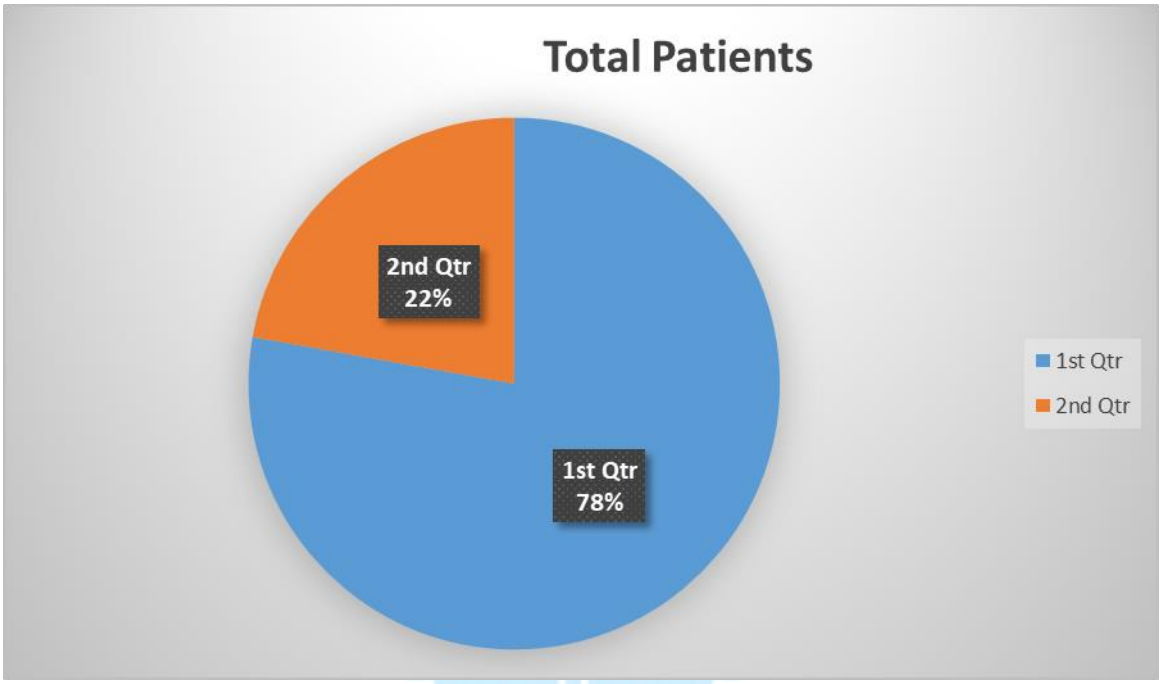
Once an ulcer has developed, there is a high risk of it leading to below-knee amputation. Limb amputations are the most costly and feared consequence of foot ulcers. In diabetics, 84% of non-traumatic limb amputations are preceded by foot ulcers.[23]

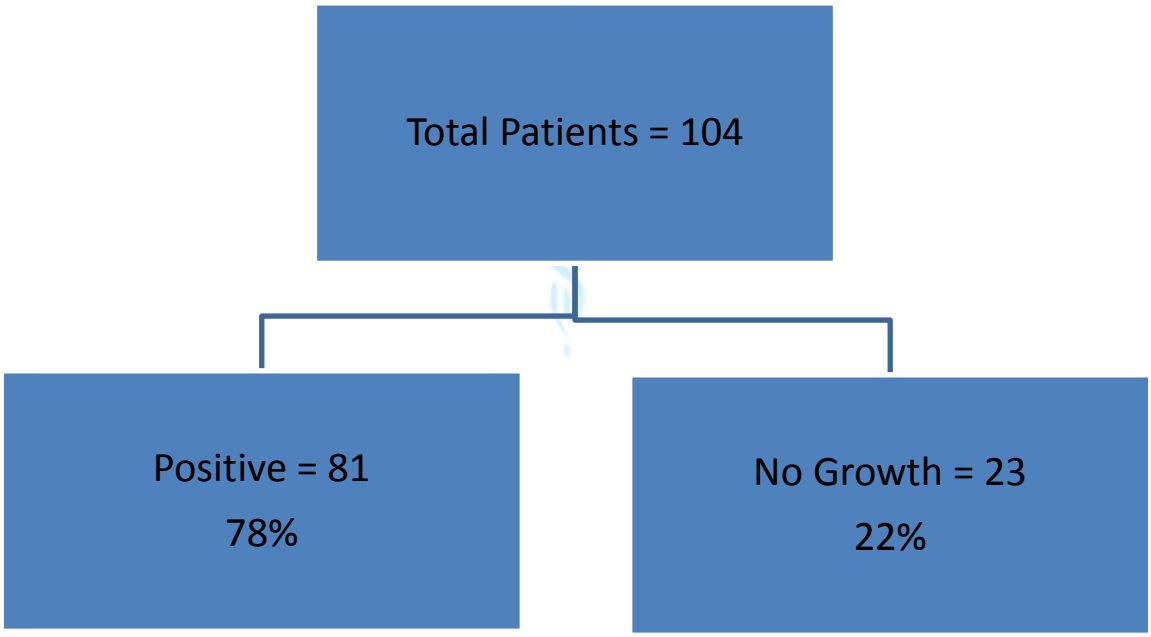
This group is 25 times more at risk of a limb amputation as compared to people without diabetes mellitus.[24]

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Total Patients:

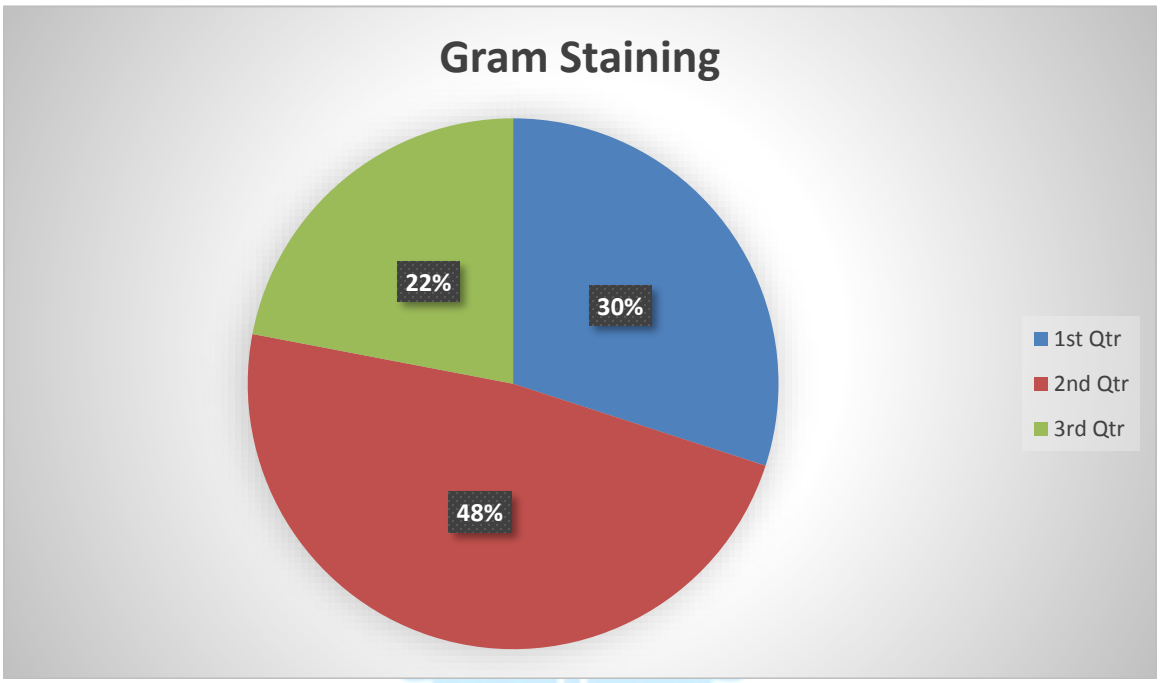




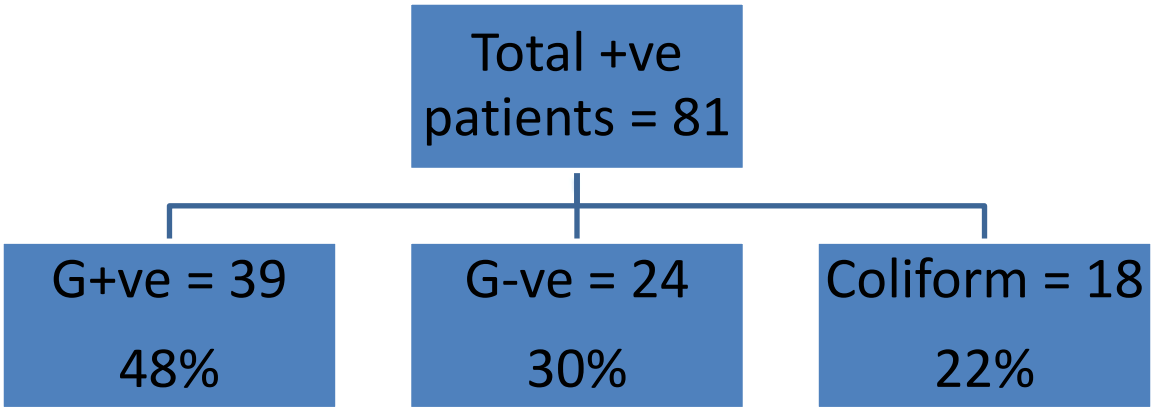
The data is collected from 104 diabetic foot ulcer patients presented to MMC, out of which the pus swab culture and sensitivity report of 81 patients was positive, showing the growth of different organisms while the rest of 23 cases was negative, showing no growth.

It is clear from lab reports that out of 81 positive cases 24 are gram negative, 39 are gram positive and 18 were coliform.

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



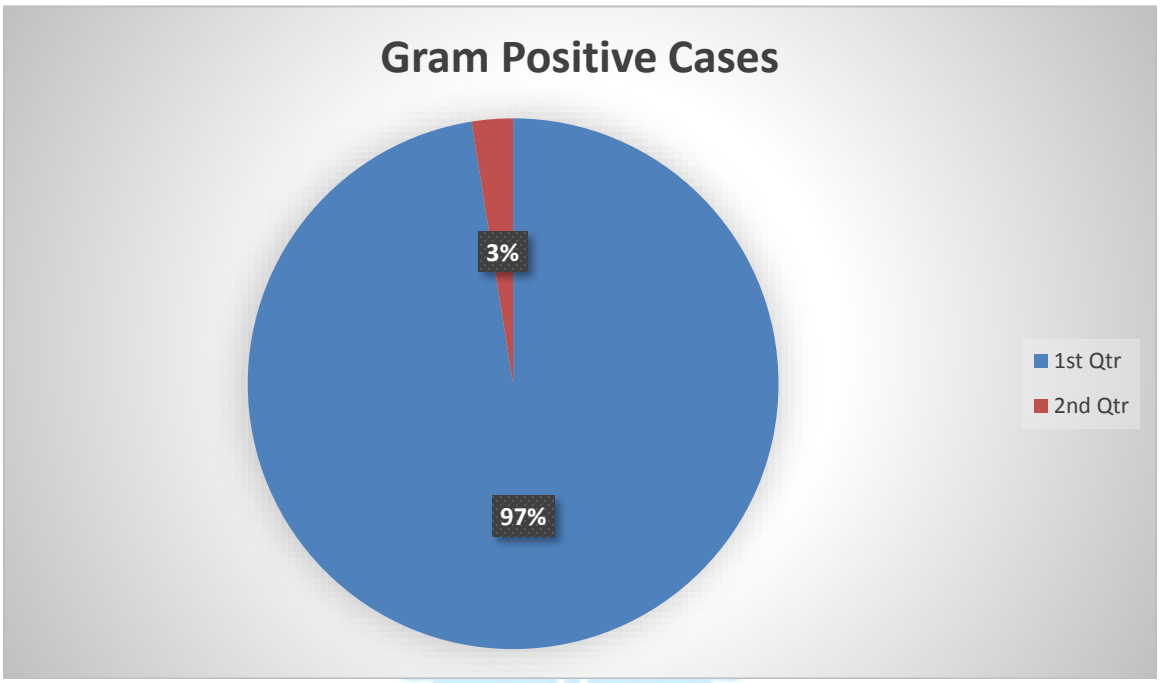
Gram Staining (G/S):

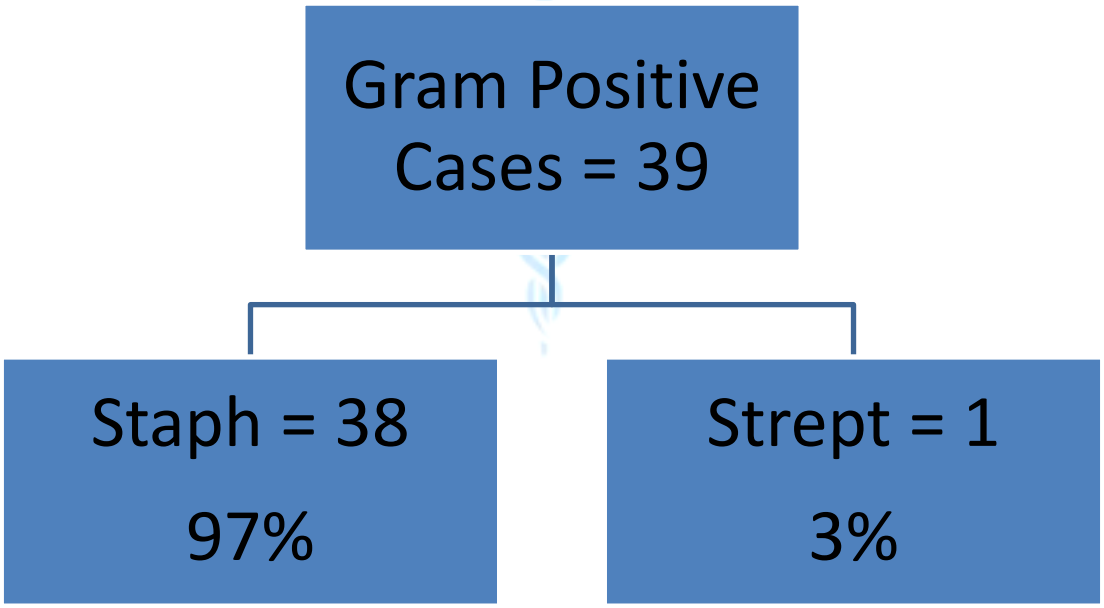


Gram Positive Cases:

The report of 39 patients showing gram positive result out of which 38 is staphylococcus and 1 is streptococcus.

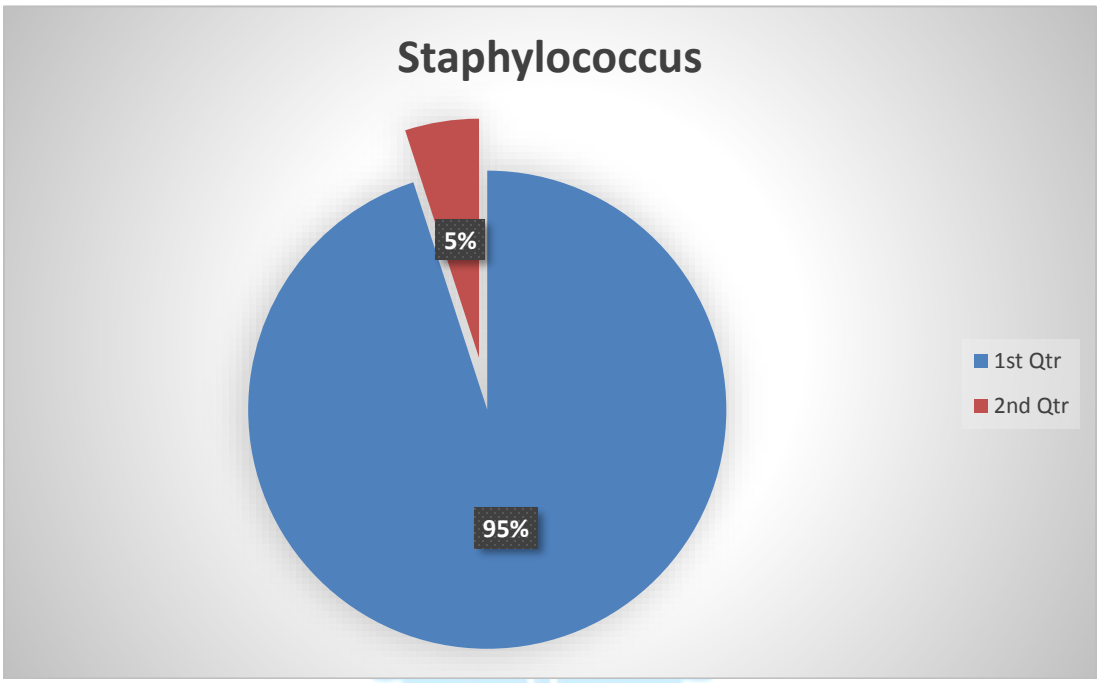
Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

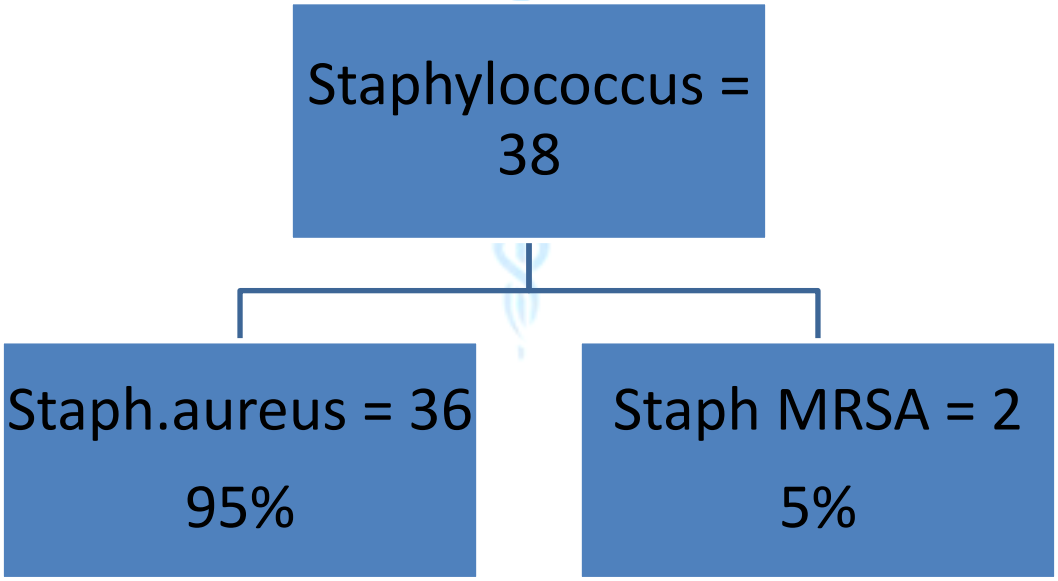




Staphylococcus:
Out of 38 staphylococcus patients, 2 cases were Staph. MRSA

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



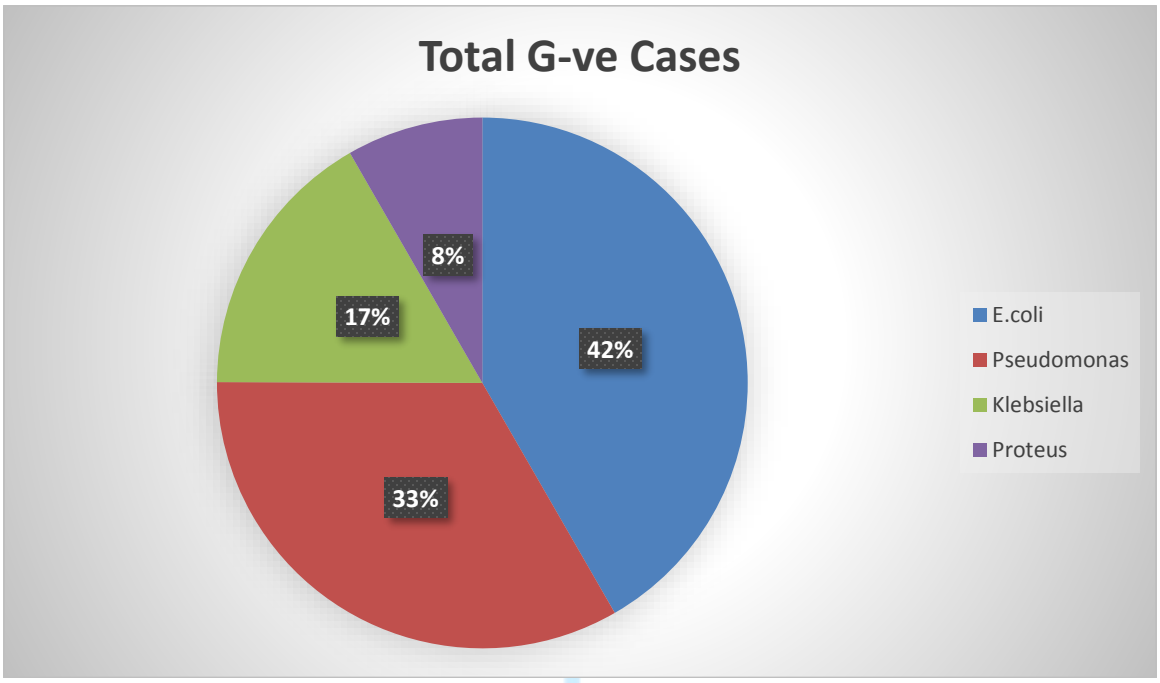


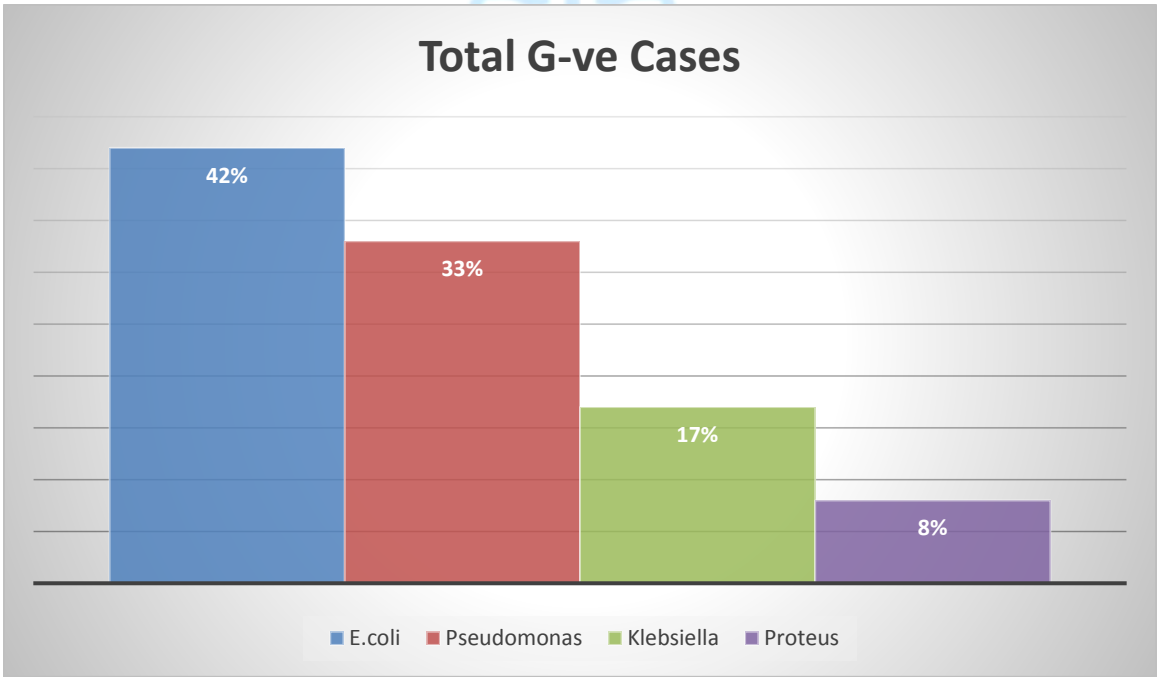
Gram Negative Cases:

Out of total 24 gram negative cases 10 cases are Escherichia coli, 8 are Pseudomonas, 4 are Klebsiella and 2 are Proteus.

Total Gram Negative Cases = 24	
Escherichia coli = 10	41.7%
Pseudomonas = 8	33.3%
Klebsiella = 4	16.67%
Proteus = 2	8.3%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593





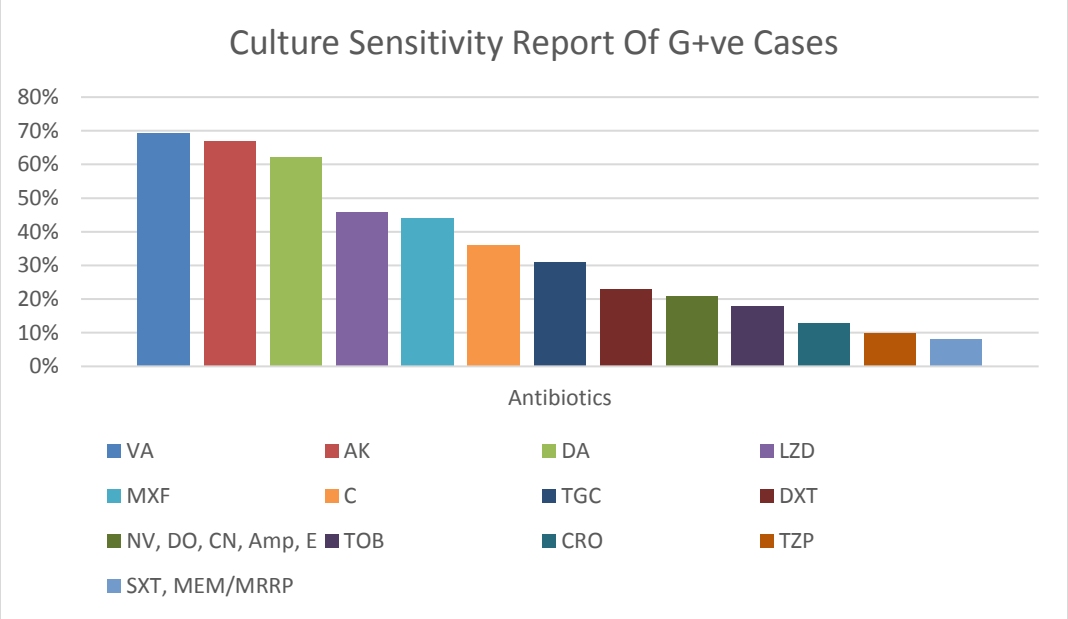
Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Culture Sensitivity Report Of G+ ive Cases:

S.No	Antibiotic	Frequency	%age
1	Vancomycin	27	69.23%
2	Amikacin	26	66.67%
3	DA	24	61.54%
4	Linezolid	18	46.15%
5	Moxifloxacin	17	43.59%
6	Chloramphenicol	14	35.90%
7	Tigecycline	12	30.77%
8	DXT	9	23.08%
9	NV, DO, CN, Amp, E	8	20.51%
10	TOB	7	17.95%
11	Ceftriaxone	5	12.82%
12	Tazobactam	4	10.26%
13	SXT, MEM/MRP	3	7.69%

Culture Sensitivity Report Of Gram Positive Cases

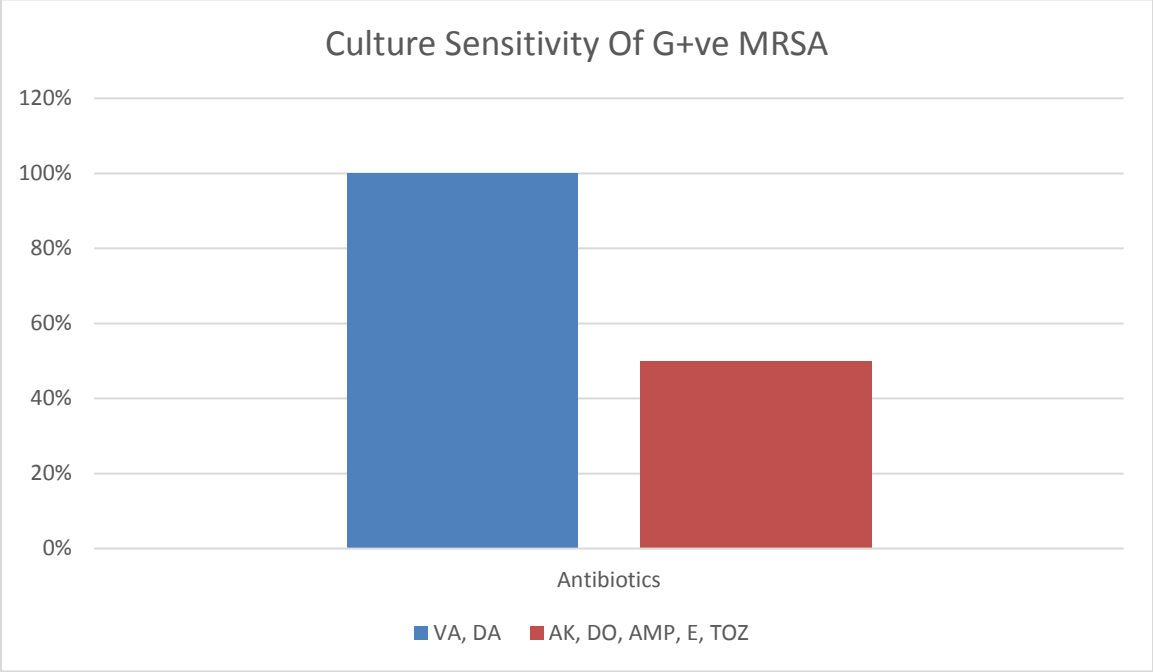


From above graph and table it is indicated that vancomycin is the highest sensitive antibiotic, responding to maximum 27 Gram positive organisms, while Amikacin is the second highest antibiotic sensitive to 26 Gram positive organisms.

Sensitivity Of Gram Positive MRSA (Methicillin Resistant staphylococcus aureus:

Sensitivity Of G+ive MRSA			
S.No	Antibiotic	Frequency	Percentage
1	VA, DA, TGC	2	100%
2	AK, DO, AMP, E, TOZ	1	50%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



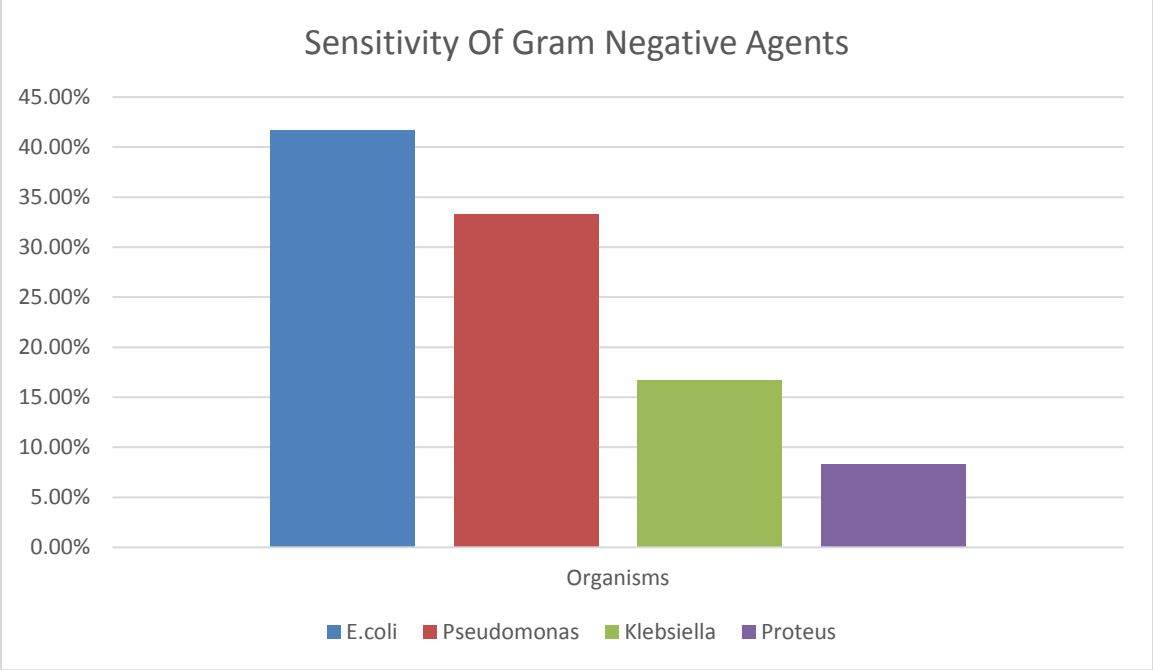
The above table and graph shows that VA, DA and TGC are 100% sensitive and AK, DO, AMP, E and TOZ are 50% sensitive to MRSA.

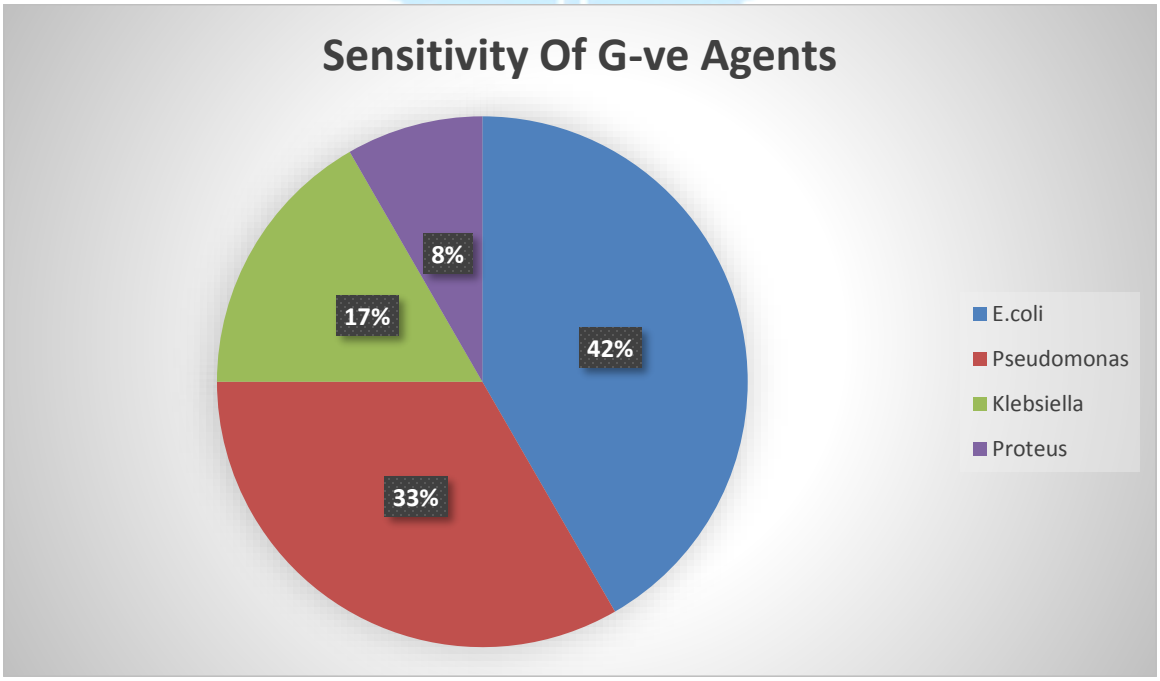
Streptococcus:
In our study only 1 case of streptococcus is +ve which shows 100% sensitivity to AK and DO.

Sensitivity Of Gram Negative Agents:
Out of 81 positive cases 29.63% that is 24 cases are Gram negative in which maximum 10 cases are E.coli, 8 are Pseudomonas, 4 are Klebsiella and 2 are Proteus.

Sensitivity Of Gram Negative Agents			
S.NO	Organism	Frequency	Percentage
1	E.coli	10	41.67%
2	Pseudomonas	8	33.33%
3	Klebsiella	4	16.67%
4	Proteus	2	8.33%

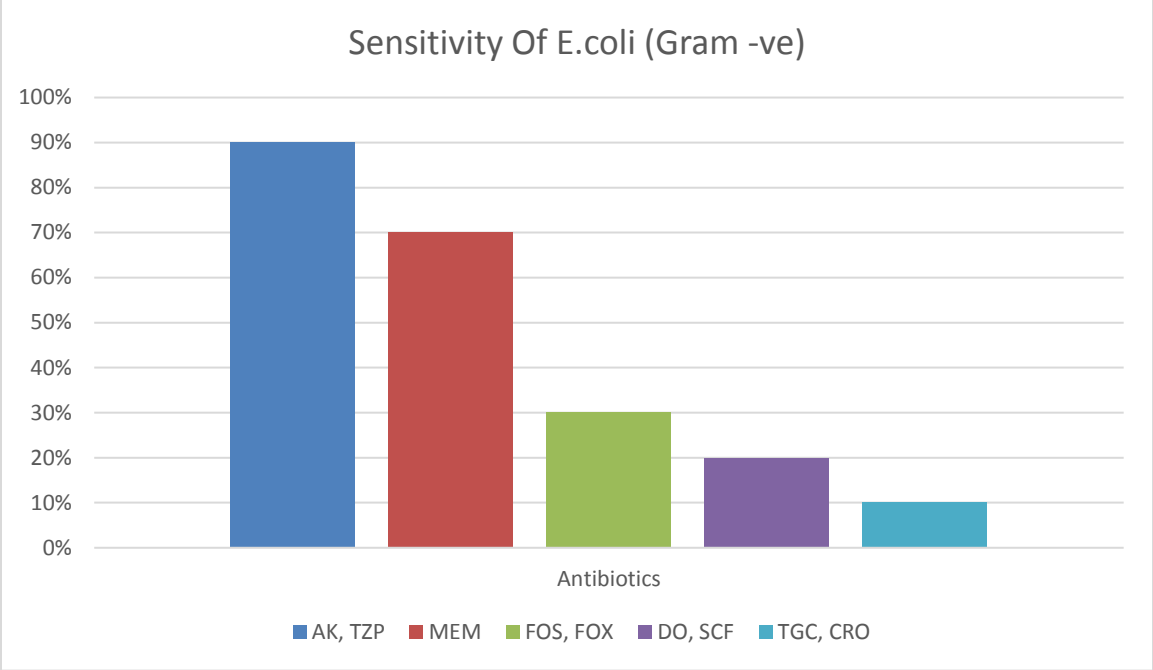
Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593





Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

Sensitivity Report Of E.coli (Gram –ve):



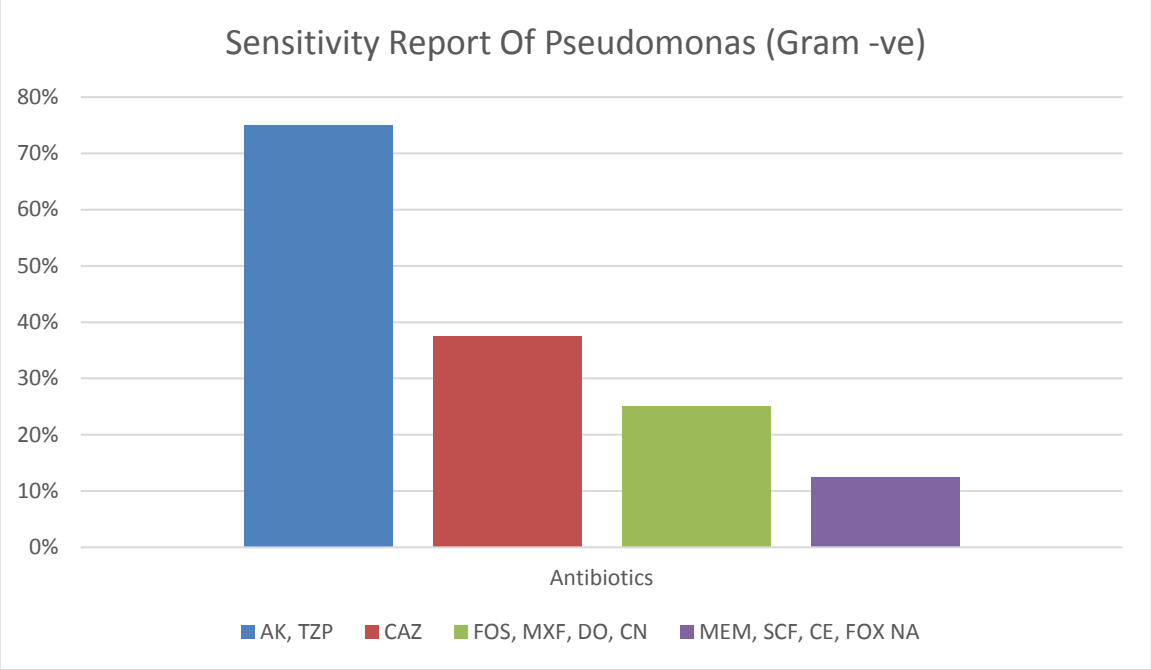
Sensitivity Report Of (Gram –ve) E.coli			
S.NO	Antibiotics	Frequency	Percentages
1	AK, TZP	9	90%
2	MEM	7	70%
3	FOS, FOX	3	30%
4	DO, SCF	2	20%
5	TGC, CRO	1	10%

This graph and table indicates that Gram negative E.coli is highly sensitive to AK and TZP (90%) and minimum sensitive to TGC and CRO.

Sensitivity Report Of Pseudomonas (Gram –ve):

Sensitivity Report Of (Gram-ve) Pseudomonas			
S.No	Antibiotics	Frequency	Percentages
1	Amikacin, Tazobactam+Piperacillin	6	75%
2	Ceftazidime	3	37.5%
3	Fosfomycin, moxifloxacin doxycycline, gentamicin	2	25%
4	Meropenem, cefoperazone+sulbactam, cefepime, cefoxitin,nalidixic acid	1	12.5%

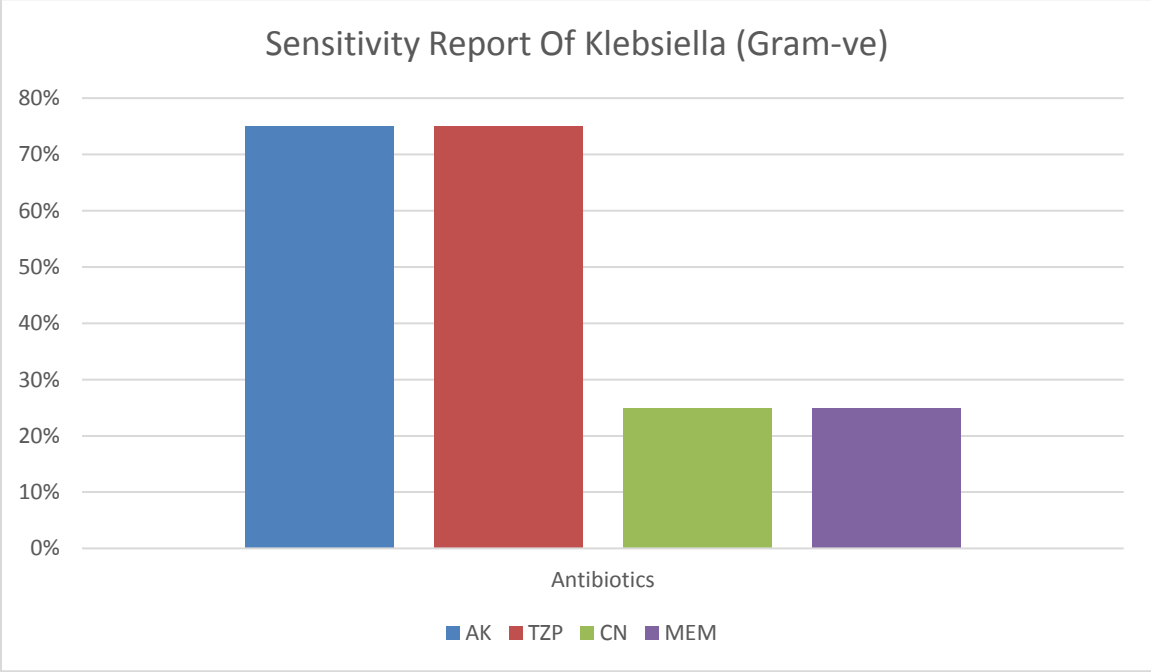
Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



AK and TZP are the highest sensitive antibiotic to Gram negative Pseudomonas i.e 75% sensitive.

Sensitivity Report Of Klebsiella (Gram –ve):

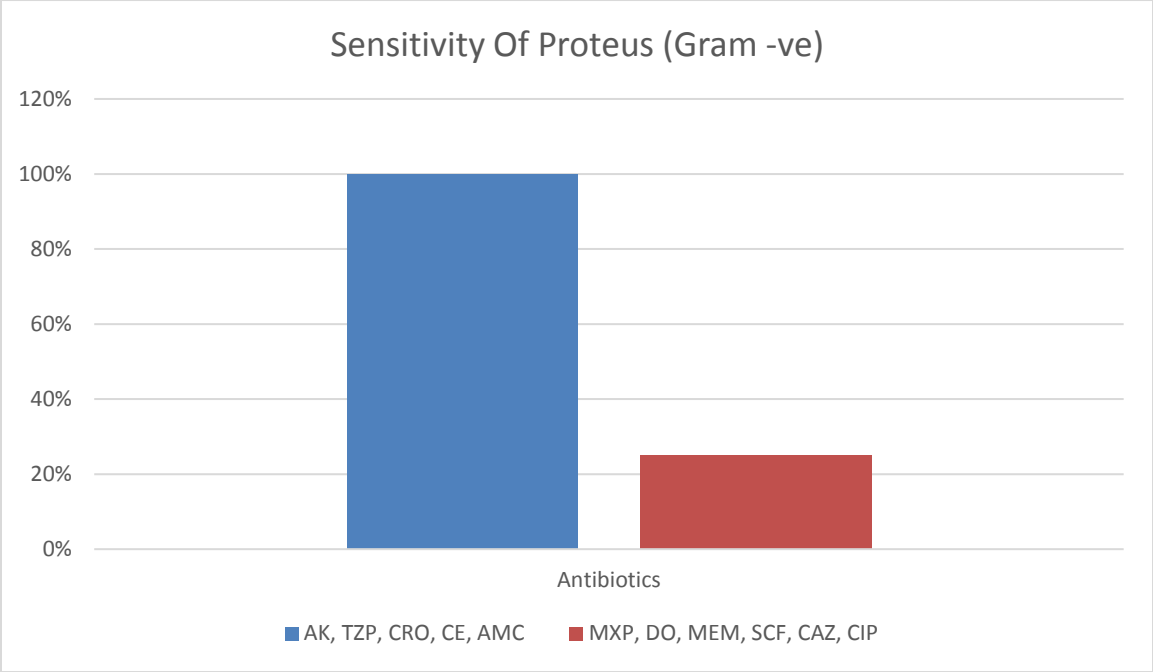
Sensitivity Report Of Klebsiella (Gram-ve)			
S.NO	Antibiotic	Frequency	Percentages
1	Amikacin, tazobactam+piperacillin	3	75%
2	Gentamycin, meropenem	1	25%



Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

This graph and table indicates that AK and TZP are the highest sensitive group to Gram negative Klebsiella which covers upto 75%.

Sensitivity Report of Proetus (Gram –ve):

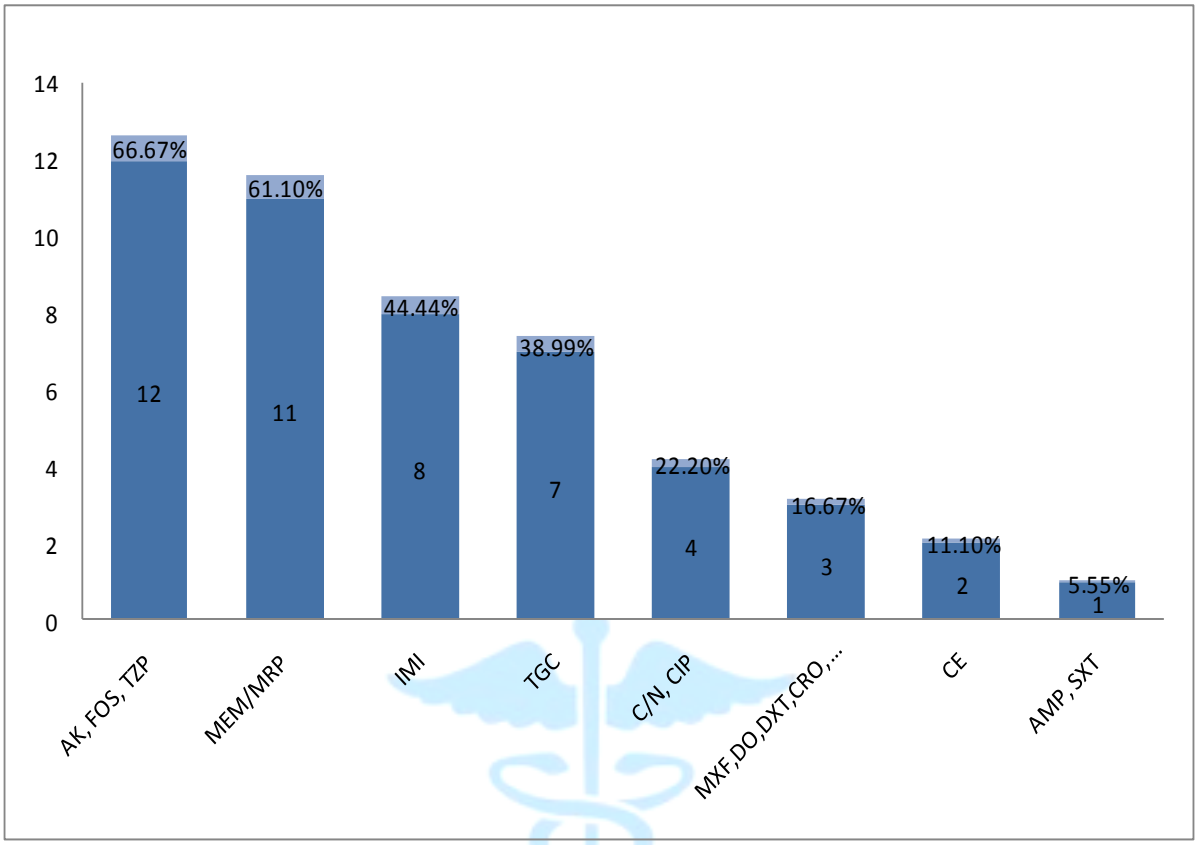


Laboratory result of pus c/s of diabetic foot ulcer shows 100% sensitivity to AK, TZP, CRO, CE and AMC, while only 25% sensitivity to MXP, DO, MEM, SCF, CAZ and CIP.

SENSITIVITY OF COLIFERON

S.No	Antibiotic	f	%age
1	AK, FOS, TZP	12	66.67%
2	MEM/MRP	11	61.10%
3	IMI	8	44.44%
4	TGC	7	38.99%
5	C/N, CIP	4	22.20%
6	MXF,DO,DXT,CRO,SCF	3	16.67%
7	CE	2	11.10%
8	AMP, SXT	1	5.55%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



From data table & Bar graph demonstrated above, it is indicated that AK,FOS & TZP are the highest antibiotic, which effect on maximum organism (66.67%) while AMP & SXT are less sensitive antibiotic (5.55%).

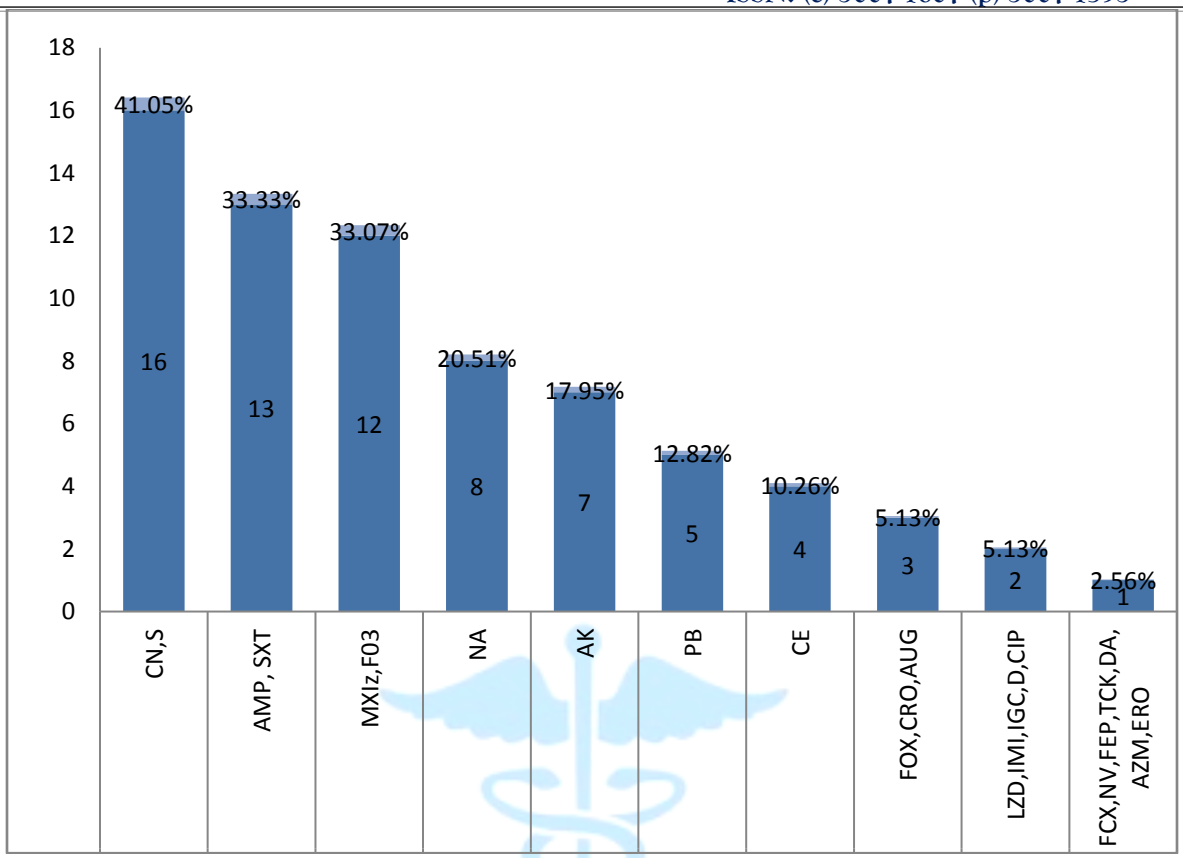
RESTISTANT GROUP OF ANTIBIOTIC

So far we study in detail and demonstrate sensitivity of antibiotic to various pathogens,
Now we will study Resistant

Resistant to G +Ve bacteria

S.No	Antibiotic	f	%age
1	CN,S	16	41.05%
2	AMP, SXT	13	33.33%
3	MXIz,F03	12	33.07%
4	NA	8	20.51%
5	AK	7	17.95%
6	PB	5	12.82%
7	CE	4	10.26%
8	FOX,CRO,AUG	3	5.13%
9	LZD,IMI,IGC,D,CIP	2	5.13%
10	FCX,NV,FEP,TCK,DA,AZM,ERO	1	2.56%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



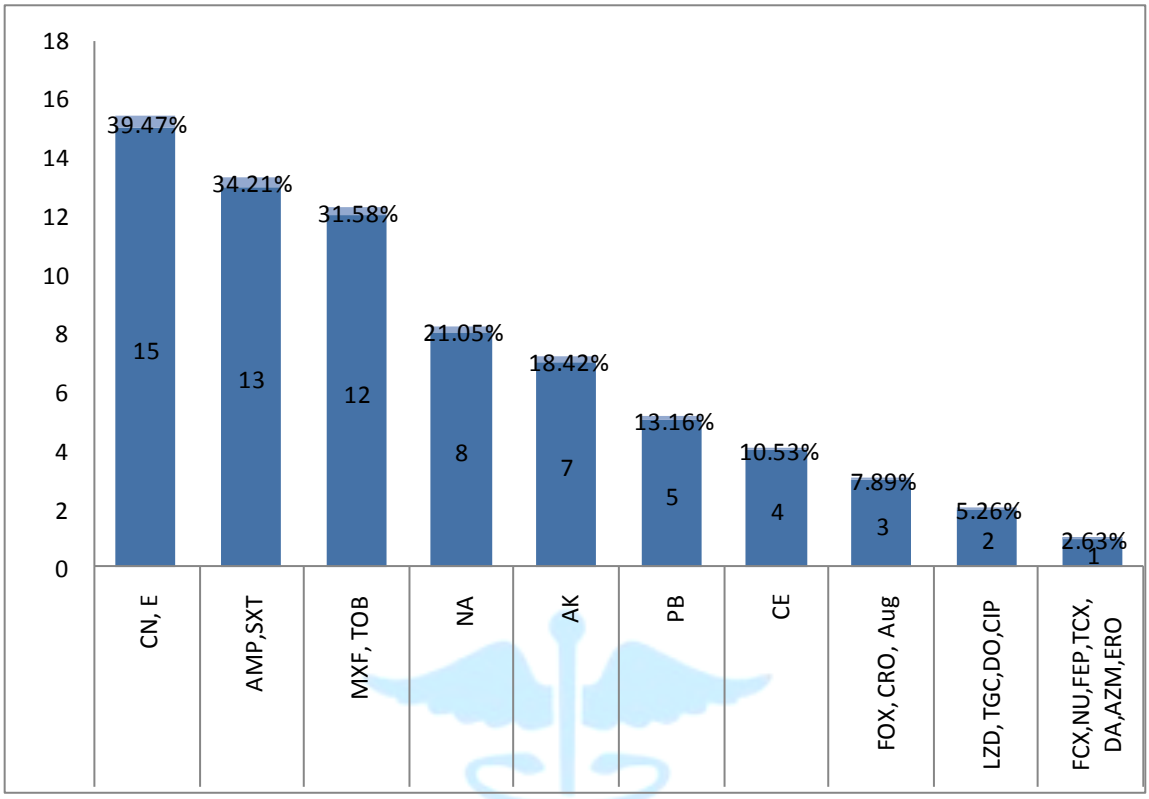
This table and bar graph indicate that CN&E are such antibiotic, which show maximum resistant to overall G+Ve organism.

Now we will demonstrate resistant of two common groups of G.+Ve organism i.e staphylococus and streptococus one by one.

RESTISTANT TO STAPH (G. +IVE)

S.No	Antibiotic	f	%age
1	CN, E	15	39.47%
2	AMP,SXT	13	34.21%
3	MXF, TOB	12	31.58%
4	NA	8	21.05%
5	AK	7	18.42%
6	PB	5	13.16%
7	CE	4	10.53%
8	FOX, CRO, Aug	3	7.89%
9	LZD, TGC,DO,CIP	2	5.26%
10	FCX,NU,FEP,TCX,DA,AZM,ERO	1	2.63%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



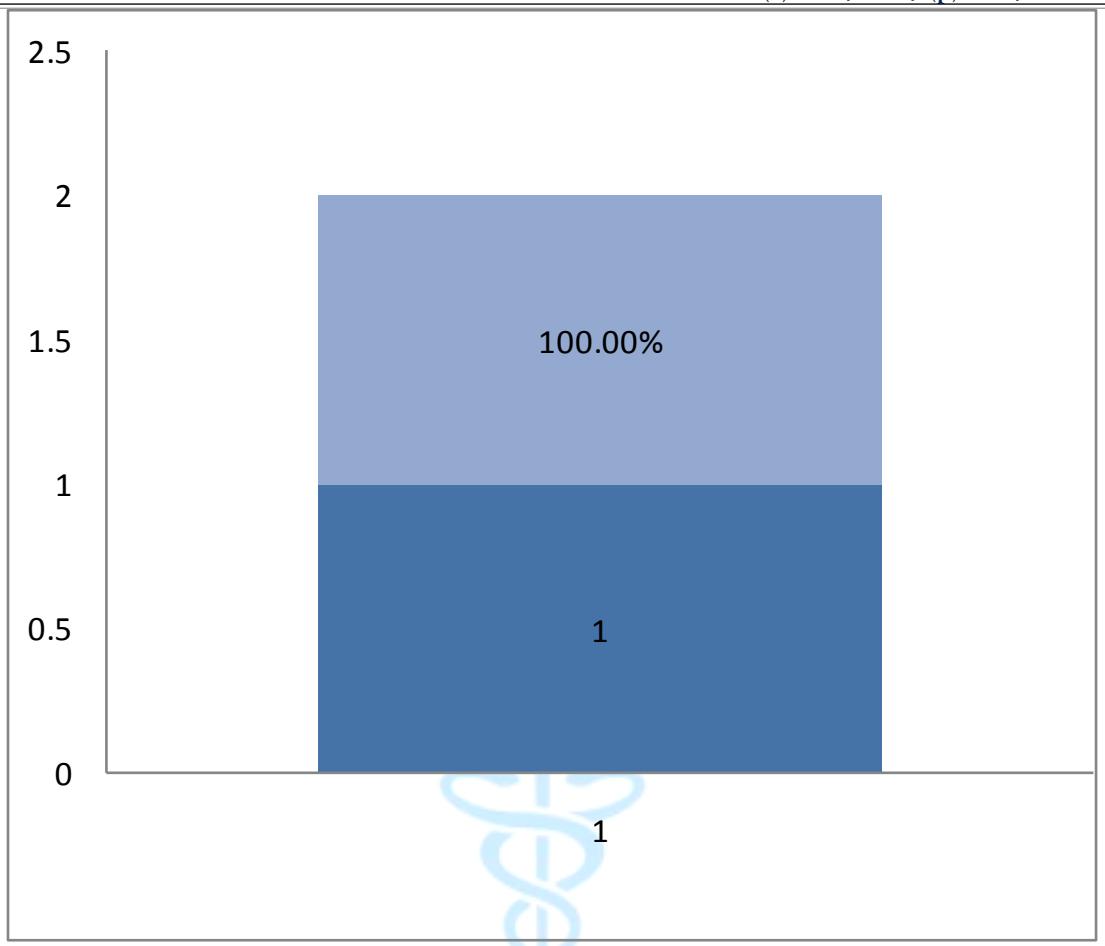
This table and bar graph indicate that CN&E are highly resistant to staph (G.+ve) i.e. 39.47%.

RESTISTANT TO STREPTOCOCUS (G. +IVE)

S.No	Antibiotic	f	%age
1	LZD,NA,DA,CN,E,SXT	1	100.00%

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

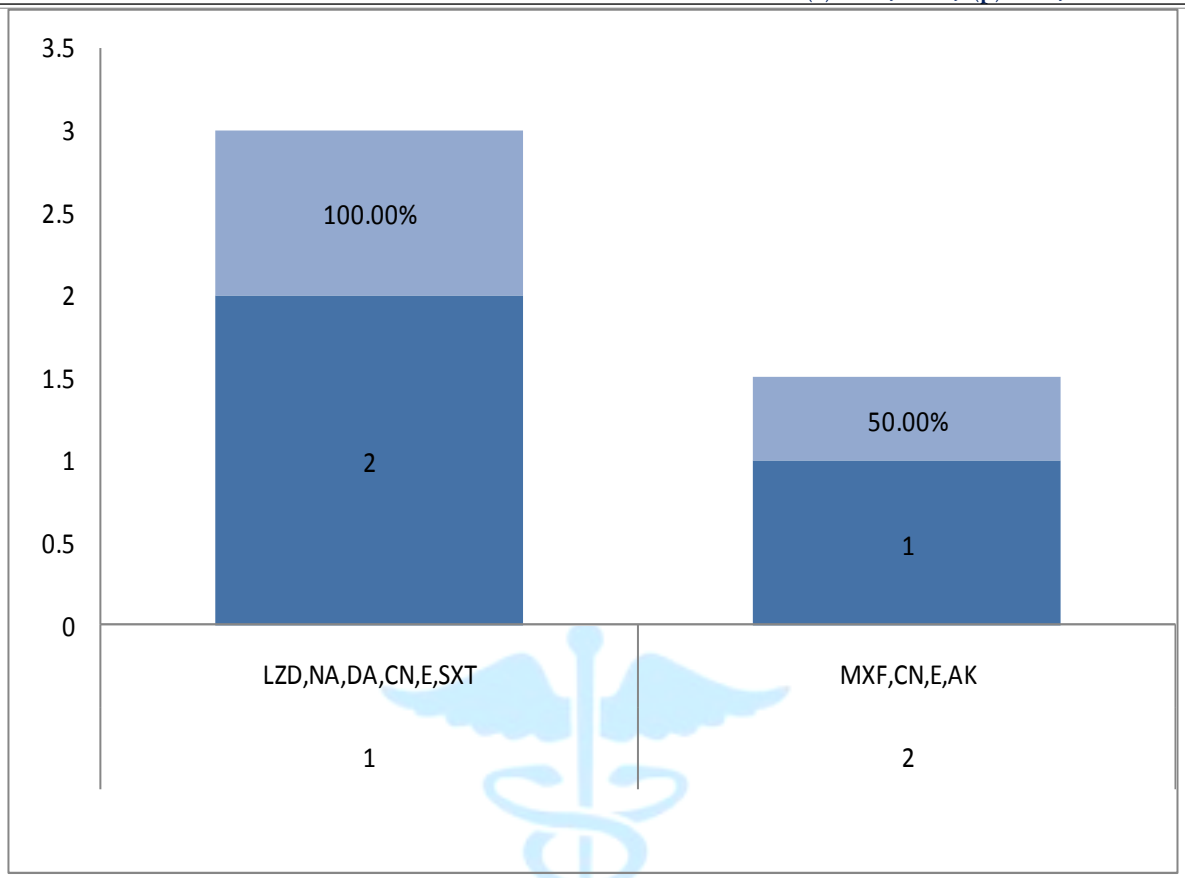


From above mentioned graph and table it is clearly indiated that G+vestreptococus is 100%. Resistant to LZD,NA,DA,CN,E and SXT.

RESTISTANT TO STAPH MRSA

S.No	Antibiotic	f	%age
1	LZD,NA,DA,CN,E,SXT	2	100.00%
2	MXF,CN,E,AK	1	50.00%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



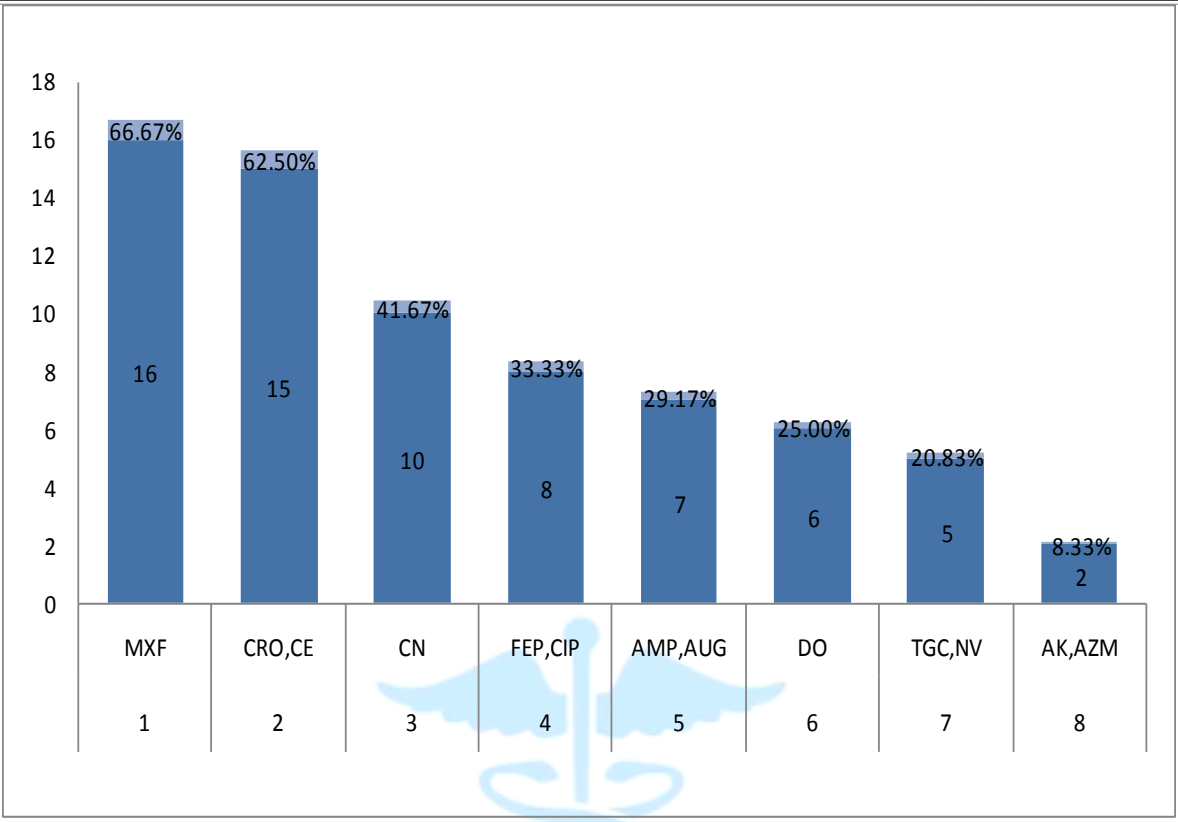
As it is clear from above demonstrated chart and bar graph that Staph MRSA are 100% resistant to SXT and 50% resistant to MXF,C,E and AK

RESISTANT TO GRAM -VE ORGANISM

S.No	Antibiotic	f	%age
1	MXF	16	66.67%
2	CRO,CE	15	62.50%
3	CN	10	41.67%
4	FEP,CIP	8	33.33%
5	AMP,AUG	7	29.17%
6	DO	6	25.00%
7	TGC,NV	5	20.83%
8	AK,AZM	2	8.33%

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

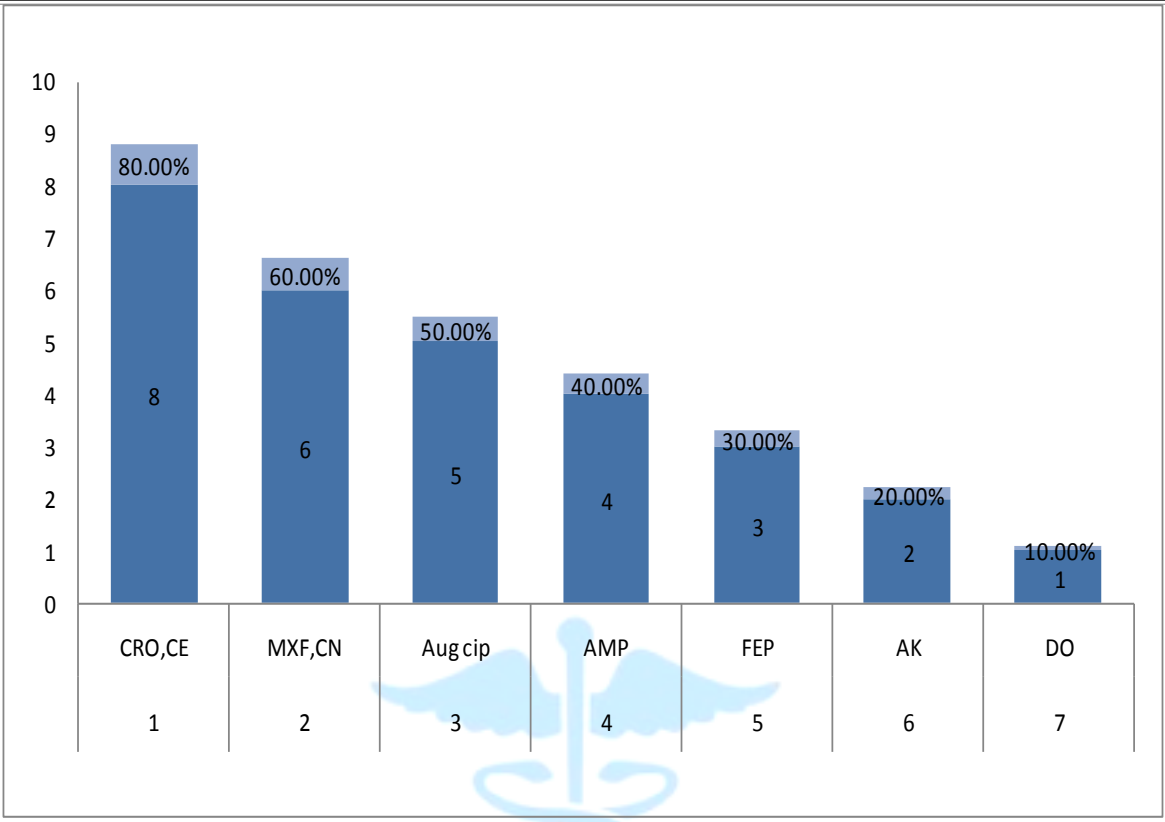


Overall report show that G-ve organism are highly resistant to MXF i.e 66.67%and lowest resistant to AK and AZM i.e 8.33%

RESISTANT TO E.COLI(GRAM -VE)

S.No	Antibiotic	f	%age
1	CRO,CE	8	80.00%
2	MXF,CN	6	60.00%
3	Aug cip	5	50.00%
4	AMP	4	40.00%
5	FEP	3	30.00%
6	AK	2	20.00%
7	DO	1	10.00%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

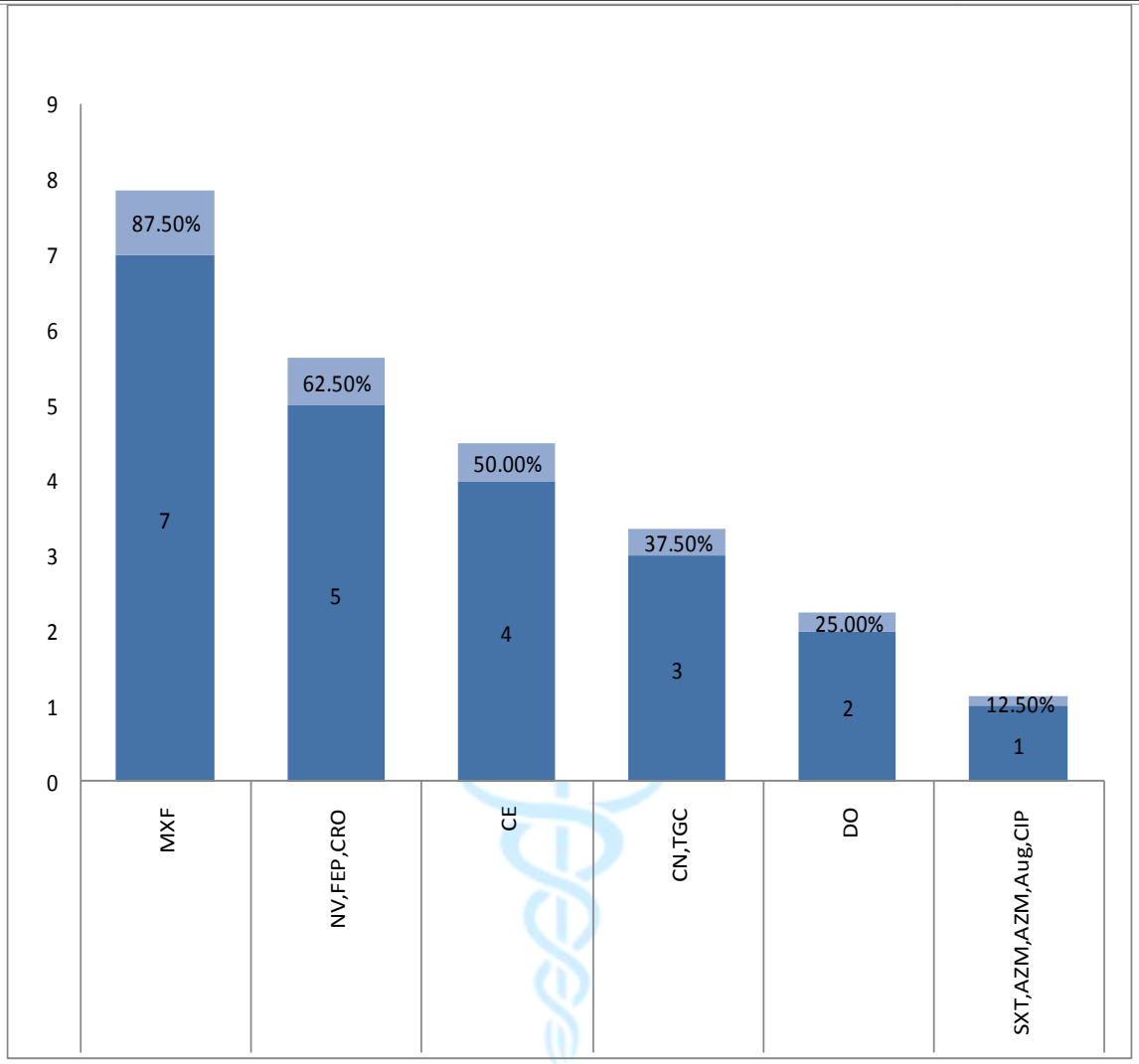


Gram -Ve, E.Coli show highly resistant to CRO and CE(80%) while mimimum restant to AK and DO i.e 20% and 10% respectively.

RESISTANT TO PSUDOMONAS(GRAM -VE)

S.No	Antibiotic	f	%age
1	MXF	7	87.50%
2	NV,FEP,CRO	5	62.50%
3	CE	4	50.00%
4	CN,TGC	3	37.50%
5	DO	2	25.00%
6	SXT,AZM,AZM,Aug,CIP	1	12.50%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

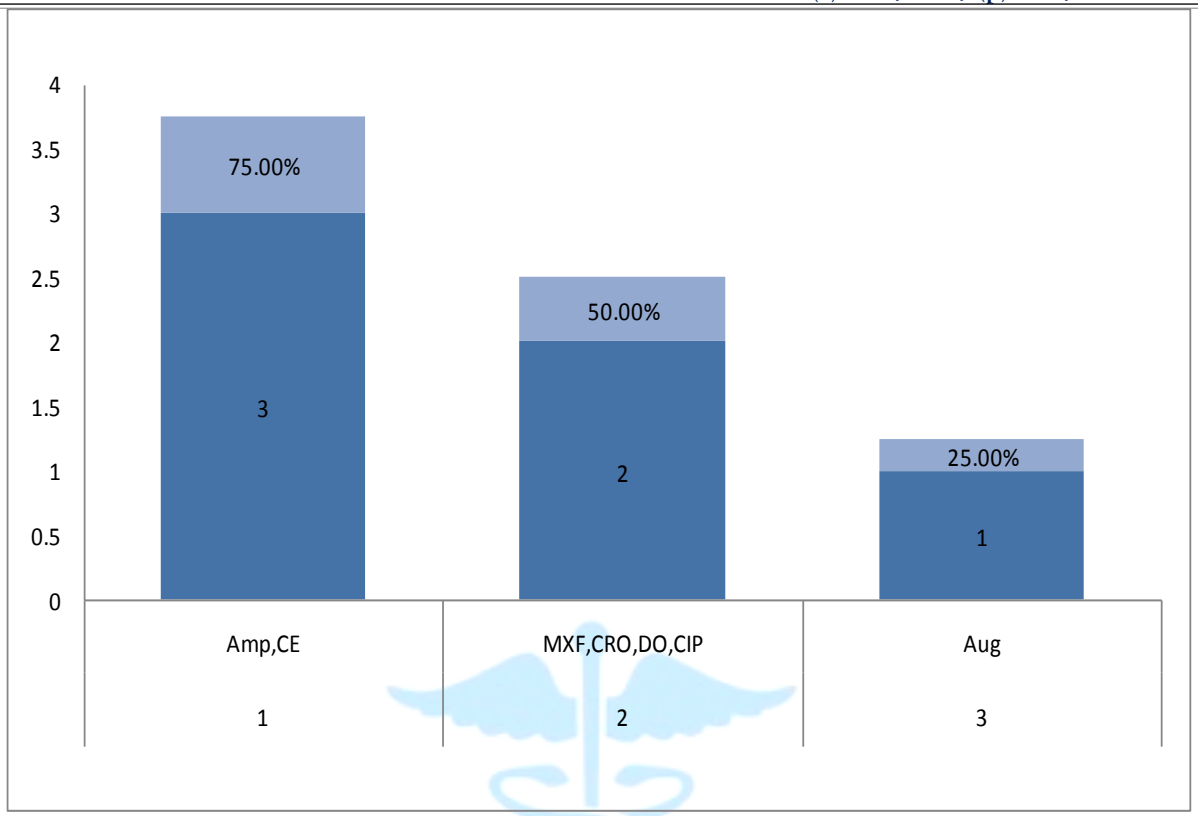


This table and graph demonstrate that(-Ve) Psudomonas show maximum resistant (87.5%)to MXF and minimum resistant to SXT,AZM,Aug and CIP(2.5%)

RESISTANT TO KLEBSIELA(GRAM -VE)

S.No	Antibiotic	f	%age
1	Amp,CE	3	75.00%
2	MXF,CRO,DO,CIP	2	50.00%
3	Aug	1	25.00%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

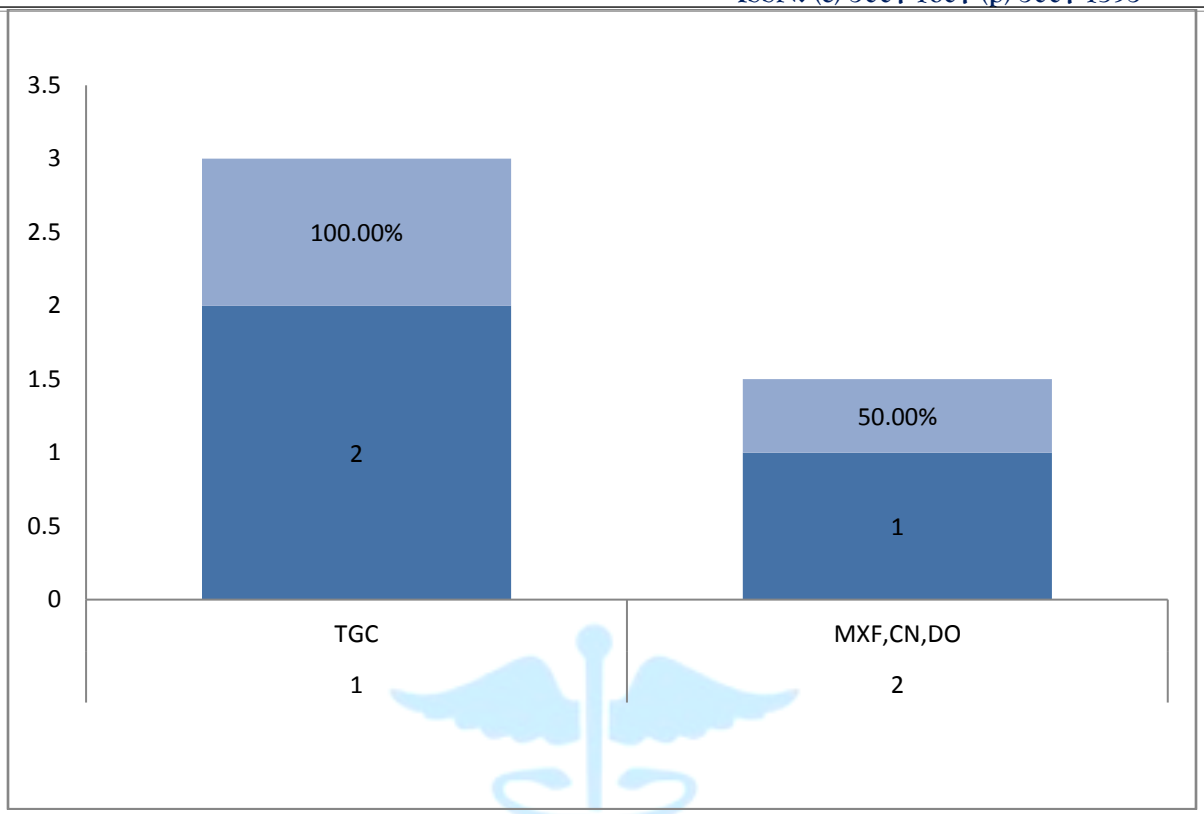


As mentioned in this table and graph, G-Ve, Klebsiele show 75% resistant to Amp and CE, while lowestresistant to Aug i.e only 25%.

RESISTANT TO PROTEASE(GRAM -VE)

S.No	Antibiotic	f	%age
1	TGC	2	100.00%
2	MXF,CN,DO	1	50.00%

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593



Protease show maximum 100% resistant to TGC and minimum 50% to MXF,CN and D0 as demonstrated above.

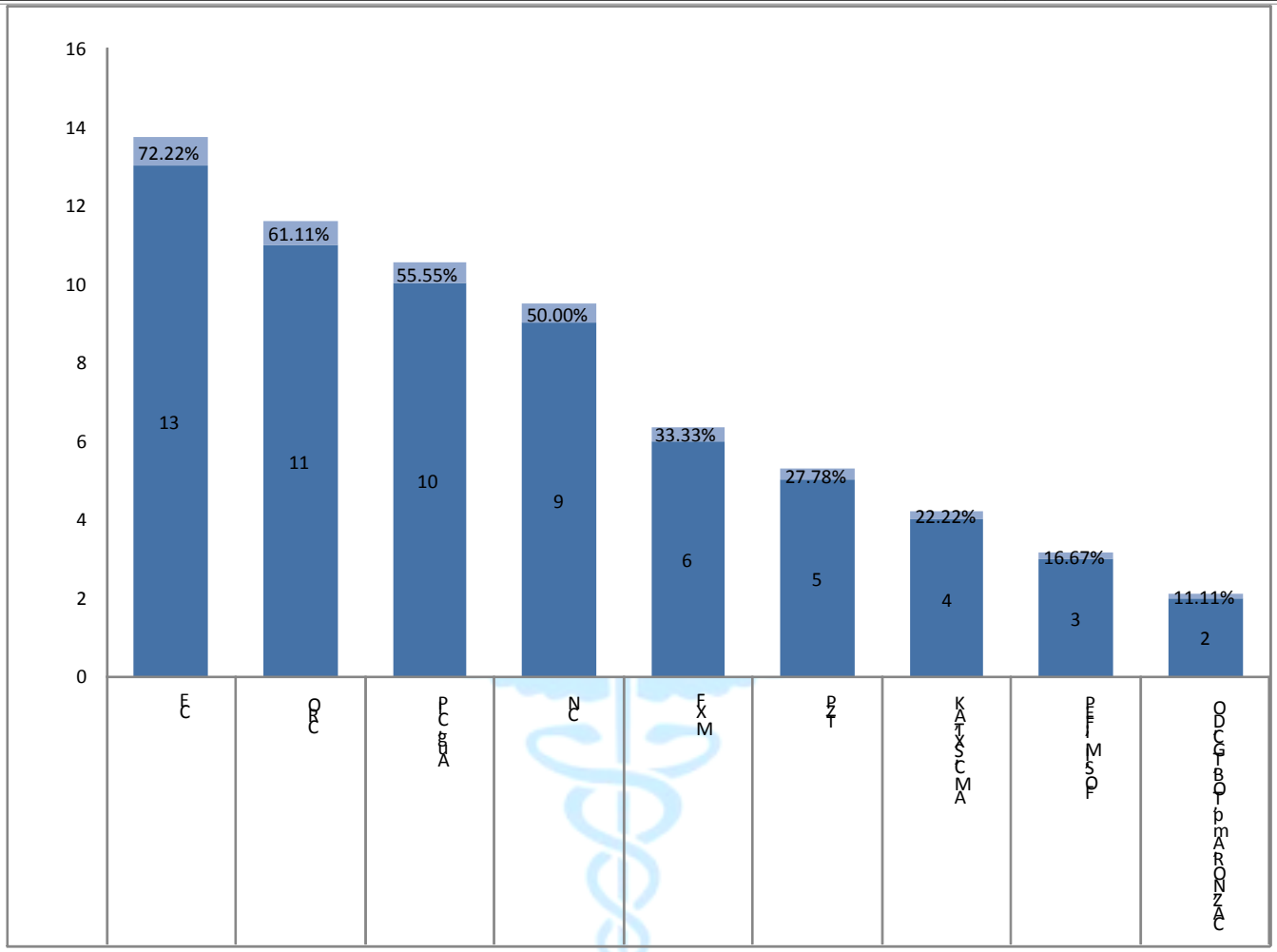
RESTISTANT OF COLIFORM

S.No	Antibiotic	f	%age
1	CE	13	72.22%
2	CRO	11	61.11%
3	Aug, CIP	10	55.55%
4	CN	9	50.00%
5	MXF	6	33.33%
6	TZP	5	27.78%
7	AMC,SXT,AK	4	22.22%
8	FOS,IMI,FEP	3	16.67%
10	CAZ,NOR,Amp,TOB,TGC,DO	2	11.11%

Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593



As it is clearly mentioned from above table and graphs that Coliform show maximum(72.22%) resistant to CE and minimum only 11.11% resistant to CAZ NOR, Amp, TOB, TGC and DO.

PERSONAL OBSERVATION This data is collected from total 104 patients, presented to MMCTH, with Diabetic foot ulcer, out of which 60 were male and 44 were female.

3. MATERIALS AND METHODS

3.1 Study Design and Setting:

This descriptive, cross-sectional study relied on primary clinical data collected from patients presenting with diabetic foot ulcers (DFUs) to the Surgical Department of the Mardan Medical Complex Teaching Hospital (MMCTH) in Mardan, Khyber Pakhtunkhwa, Pakistan. The prospective data collection period commenced in February 2018 and concluded in July 2018. The primary objective of the investigation focused on evaluating the specific microbiological profiles, alongside the corresponding antimicrobial culture and susceptibility patterns, of isolated wound pathogens.

3.2 Sampling Protocol and Study Population:

A random sampling technique was utilized to recruit participants from the hospital's target demographic. A total cohort of 104 patients diagnosed with infected DFUs was successfully enrolled. Of these 104 subjects, 60 were male and 44 were female. Data collection was executed using a standardized, structured questionnaire proforma designed to capture essential clinical and demographic determinants. These metrics included patient gender, socioeconomic

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

background, educational attainment level, clinical duration of Diabetes Mellitus (DM), and occupational status. To respect cultural sensitivities and ensure accurate data acquisition, interviews for male patients and elderly female subjects were conducted through direct face-to-face communication. Conversely, data from younger female respondents was gathered utilizing an indirect methodology facilitated by an intermediary family member.

3.3 Microscopic and Microbiological Screening:

Wound care and sample isolation involved the aseptic collection of pus swab specimens from the active ulcer sites of all 104 patients. These specimens were processed by standard laboratory techniques to identify causative organisms and map their resistance and sensitivity properties. Out of the total sample pool, 81 specimens returned culture-positive results, while 23 showed no microbial growth.

3.4 Statistical Analysis:

All gathered demographic and microbiological data were compiled and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 16.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were generated, where qualitative and categorical data—including pathogen prevalence, therapeutic sensitivity levels, and antibiotic resistance rates—were presented as absolute frequencies and percentages. The final datasets are visually supported using structured analytical tables, pie charts, and comparative bar graphs to ensure clarity and scannability.

SUMMARY

Diabetes Mellitus (DM) represents a major global health emergency, with its prevalence, incidence rates, and clinical complications showing significant variations across different countries and geographic territories. Among the most severe secondary complications of poorly controlled diabetes is the development of lower-extremity ulcerations. The core objectives of this clinical study were to isolate and determine the highly prevalent microbiological agents responsible for wound infections in diabetic foot ulcer (DFU) patients, while evaluating the therapeutic sensitivity and resistance profiles of these isolates against common classes of antimicrobial groups within the local healthcare setting. To achieve these endpoints, clinical data was prospectively gathered from a total cohort of 104 patients presenting with active diabetic foot ulcers to the surgical department of the Mardan Medical Complex Teaching Hospital (MMCTH) in Mardan, Pakistan. Demographically, the study cohort consisted of 60 male individuals (57.69%) and 44 female individuals (42.31%). Microbiological evaluation involved screening pus swabs collected from the ulcer sites for specimen culture and standard antimicrobial susceptibility profiling. Out of the 104 clinical cases evaluated, 81 specimens demonstrated positive microbial growth, whereas the remaining 23 cultures returned negative results showing no distinct colonization. The microbiological analysis revealed a high burden of opportunistic pathogens. Staphylococcus aureus was identified as the single most dominant causative pathogen isolated during the study, accounting for 38 distinct cases, which constitutes 46.91% of the 81 culture-positive specimens. Phenotypic testing further confirmed that two of these staphylococcal isolates were Methicillin-Resistant Staphylococcus aureus (MRSA) strains. Regarding therapeutic efficacy against Gram-positive isolates, Vancomycin emerged as the most potent bactericidal agent, demonstrating an overall susceptibility rate of 69.23% among Gram-positive organisms, alongside achieving a 100% sensitivity rate specifically against the isolated MRSA strains within the target study area. For Gram-negative pathogens isolated from the wound cultures, combined susceptibility data showed that a management regimen utilizing Vancomycin or Piperacillin/Tazobactam offered a robust combined therapeutic sensitivity profile touching approximately 85% efficacy against the overall Gram-negative bacterial load. Gram-negative bacterial isolates like Escherichia coli and Pseudomonas aeruginosa demonstrated high therapeutic vulnerabilities to Amikacin and Piperacillin/Tazobactam. Ultimately, the study underscores that unhygienic lifestyle routines, severe negligence regarding routine foot preservation, poor compliance with follow-up

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

clinical visits, and a profound lack of awareness regarding secondary metabolic complications remain the definitive driving risk factors behind severe DFU development and subsequent lower-limb morbidity within the Mardan region. These findings highlight the critical necessity of managing local empirical therapy regimens based on ongoing institutional culture and sensitivity profiles to mitigate the risks of multi-drug resistance.

4. RESULTS AND DISCUSSION

Total of 104 diabetic foot ulcer (DFU) patients presenting to the Surgical Department of Mardan Medical Complex Teaching Hospital (MMCTH) were enrolled in this investigation. Out of these 104 clinical presentations, 81 specimens (77.88%) yielded positive microbial growth upon culture analysis, whereas 23 specimens (22.12%) showed no growth. The high rate of culture-positive specimens emphasizes that active secondary infection remains a critical clinical complication among DFU individuals within the Mardan region. The baseline demographic distribution of the study cohort revealed a distinct male predominance, with 60 male patients (57.69%) compared to 44 female patients (42.31%). This finding aligns with international clinical trends where males display higher vulnerability to advanced foot ulcerations. This pattern is heavily driven by increased outdoor occupational activities, extended exposure to micro-trauma, a delay in seeking healthcare, and poor baseline foot-hygiene practices. Furthermore, lifestyle and systemic variations revealed a significant disparity between diabetes phenotypes: an overwhelming majority of the infections occurred in individuals with Type 2 Diabetes Mellitus (84%) compared to Type 1 Diabetes Mellitus (16%). Age stratification showed that the 52–62 age cohort was the most heavily affected group in the study area.

Table 4.1: Gram Staining and Microbial Distribution of Positive Cultures (n = 81)

Microbial Category	Specific Isolated Pathogen	Frequency (n)	Percentage (%)
Gram-Positive (n=39)	*Staphylococcus aureus* (MSSA)	36	44.44%
	Methicillin-Resistant *S. aureus* (MRSA)	2	2.47%
	Streptococcus spp.	1	1.23%
Gram-Negative (n=24)	*Escherichia coli*	10	12.35%
	Pseudomonas aeruginosa	8	9.88%
	Klebsiella spp.	4	4.94%
	Proteus spp.	2	2.47%
Coliform (n=18)	Mixed Coliform Bacteria	18	22.22%

4.1 Prevalence of Female DFU Patients and Specific Risk Dynamics:

Evaluating the disease distribution among female patients (42.31%) highlights specific socioeconomic and behavioral vulnerabilities. Clinical records indicated a higher frequency of ulceration involving the right foot, presenting with varying clinical grades and deep tissue involvement. A critical risk factor identified in the rural sectors of the Mardan district is the occupational exposure of female individuals. Diabetic females actively participating in agricultural fields and livestock management experience significantly higher ulcer complication rates than housewives or office professionals. This is directly attributed to repetitive minor trauma from rough terrain, working barefoot or in unprotective footwear, and poor local hygiene. Additionally, baseline awareness regarding Diabetes Mellitus and its secondary vascular or neurological complications was profoundly inadequate among rural and uneducated female cohorts, directly resulting in delayed medical consultations and worse clinical outcomes.

4.2 Antimicrobial Susceptibility and Resistance Profiles:

Regarding therapeutic efficacy against Gram-positive isolates, Vancomycin emerged as the most reliable bactericidal agent, achieving an

Frontier in Medical & Health Research
ISSN: (e) 3007-1607 (p) 3007-1593

overall sensitivity rate of 69.23% (n = 27). Amikacin served as the second most effective alternative, demonstrating sensitivity in 66.67% (n = 26) of cases, followed closely by Clindamycin at 61.54% (n = 24). Notably, the isolated Methicillin-Resistant Staphylococcus aureus (MRSA) strains demonstrated complete 100% susceptibility to Vancomycin, Clindamycin, and Tigecycline. Conversely, alarming resistance trends were noted against frontline conventional treatments, with Gentamicin and Erythromycin exhibiting the highest resistance rates among Gram-positive organisms. For the Gram-negative bacterial spectrum (29.63% of positive cultures), Escherichia coli (41.67%) and Pseudomonas aeruginosa (33.33%) were the primary pathogens. These isolates displayed excellent therapeutic vulnerability to Amikacin and Piperacillin/Tazobactam. Escherichia coli demonstrated a 90% susceptibility rate to both agents, while Pseudomonas aeruginosa and Klebsiella spp. maintained a 75% sensitivity profile. Proteus isolates displayed 100% susceptibility across Amikacin, Piperacillin/Tazobactam, and Ceftriaxone. Resistance among Gram-negative isolates was highest against Ampicillin and early-generation Cephalosporins, particularly within the Coliform and Klebsiella strains.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:

Diabetic foot ulcer infections present a profound public health and clinical management challenge at the Mardan Medical Complex. The baseline data confirms that the vast majority of culture-positive wound infections are driven by Gram-positive pathogens, with Staphylococcus aureus serving as the single most dominant causative agent. Among the Gram-negative spectrum, Escherichia coli and Pseudomonas aeruginosa represent the primary isolates, illustrating the complex, polymicrobial nature of advanced lesions.

Vancomycin, Amikacin, and Clindamycin remain highly effective against Gram-positive bacteria, whereas Amikacin and Piperacillin/Tazobactam offer the most reliable therapeutic coverage for Gram-negative organisms. The detection of multi-drug resistant strains, including MRSA, signals an urgent need to reform empirical prescription practices. Ultimately, unhygienic lifestyle habits, poor protective footwear selection, neglect of routine foot care, and limited awareness of diabetes complications are the definitive drivers of severe DFU development and subsequent lower-limb amputations in this population.

5.2 Recommendations:

1. **Mandatory Culture-Guided Protocols:** All presenting DFU patients should undergo standard wound culture and sensitivity testing prior to the initiation of long-term antibiotic courses to prevent treatment failures.
2. **Rationalize Antibiotic Stewardship:** Hospital administrations must implement strict antimicrobial stewardship policies to control empirical broad-spectrum prescriptions, shifting therapies to targeted agents as soon as lab results are available.
3. **Strategic First-Line Selections:** For severe, deep-tissue infections where MRSA is suspected, Vancomycin should be prioritized, while Amikacin or Piperacillin/Tazobactam should form the baseline for suspected Gram-negative bacterial involvement.
4. **Targeted Public Health Campaigns:** Launch structured public awareness programs focused on rural and low-literacy populations, educating them on the critical importance of glycemic control, daily foot self-inspections, and immediate medical reporting of minor skin breaks.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

5. **Establish Specialized Podiatric Clinics:** Set up dedicated, multidisciplinary diabetic foot care units within tertiary hospitals across the province to ensure timely debridement, pressure offloading, and wound management.
6. **Focus on High-Risk Screening:** Ensure that diabetic patients with long-standing disease duration (>10 years) or confirmed peripheral neuropathy receive mandatory lower-limb neurological and vascular assessments during every routine follow-up.
7. **Empower Female Health Education:** Create specialized community-level health interventions for rural female workers to minimize agricultural-associated foot trauma through the promotion of affordable, enclosed protective footwear.
8. **Conduct Multi-Center Molecular Research:** Fund expanded clinical trials utilizing genetic sequencing to map out changing antibiotic resistance genes and plasmid-mediated resistance trends within Khyber Pakhtunkhwa.

REFERENCES

1. Lipsky BA. A report from the international consensus on diagnosing and treating the infected diabetic foot. Diabetes Metab Res Rev. 2004;20(Suppl 1):68–77. [PubMed]
2. Center for Disease Control and Prevention. National Diabetes Fact Sheet: National Estimates and General Information on Diabetes and Prediabetes in the United States. Atlanta, GA, USA: Department of Health and Human Services, Center for Disease Control and Prevention; 2011.
3. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. JAMA. 2005;293:217–28. [PubMed]
4. Richard JL, Sotto A, Lavigne JP. New insights in diabetic foot infection. World J Diabetes. 2011;2:24–32. [PMC free article] [PubMed]
5. Ismail K, Winkley K, Stahl D, Chalder T, Edmonds M. A cohort study of people with diabetes and their first foot ulcer: The role of depression on mortality. Diabetes Care. 2007;30:1473–9. [PubMed]
6. Bronze MS, Khardori R, editors. Diabetic foot infections treatment and management. Medscape. 2016. [Last accessed on 2016 Dec 15]. Available form: http://emedicine.medscape.com/article/237378-treatment.
7. Shakil S, Khan AU. Infected foot ulcers in male and female diabetic patients: A clinico-bioinformative study. Ann Clin Microbiol Antimicrob. 2010;9:2. [PMC free article] [PubMed]
8. Pappu AK, Sinha A, Johnson A. Microbiological profile of diabetic foot ulcer. Calicut Med J. 2011;9:e1–4.
9. Uckay I, Gariani K, Pataky Z, Lipsky BA. Diabetic foot infections: state-of-the-art. Diabetes Obes Metab. 2014;16:305–316. [PubMed]
10. Miyan Z, Fawwad A, Sabir R, Basit A. Microbiological pattern of diabetic foot infections at a tertiary care center in a developing country. J Pak Med Assoc. 2017;67:665–669. [PubMed]
11. Niederman MS, Craven DE, Bonten MJ, American Thoracic Society, The Infectious Diseases Society of America et al. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005;171:388–416. doi: 10.1164/rccm.200405-644ST. [PubMed] [Cross Ref]

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

12.Crouzet J, Lavigne JP, Richard JL, Sotto A, Nîmes University Hospital Working Group on the Diabetic Foot (GP30). Diabetic foot infection: a critical review of recent randomized clinical trials on antibiotic therapy. Int J Infect Dis 2011;15(9): e601–10.

13.Eckman MH, Greenfield S, Mackey WC, Wong JB, Kaplan S, Sullivan L, et al. Foot infections in diabetic patients. Decision and cost-effectiveness analysis. JAMA 1995;273(9):712–20.

14.Lavery LA, Armstrong DG, Wunderlich RP, Mohler MJ, Wendel CS, Lipsky BA. Risk factors for foot infections in individuals with diabetes. Diabetes Care 2006;29 (6):1288–93.

15. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, Deery HG, Embil JM, Joseph WS, Karchmer AW, Pinzur MS, Senneville E, Infectious Diseases Society of America 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. Clin Infect Dis. 2012;54:e132–73. [PubMed]

16. Peters EJ, Lipsky BA. Diagnosis and management of infection in the diabetic foot. Med Clin North Am. 2013;97:911–946. [PubMed]

17. Nather A, Bee CS, Huak CY, Chew JL, Lin CB, Neo S, Sim EY. Epidemiology of diabetic foot problems and predictive factors for limb loss. J Diabetes Complications. 2008;22:77–82. [PubMed]

18. Uckay I, Gariani K, Pataky Z, Lipsky BA. Diabetic foot infections: state-of-the-art. Diabetes Obes Metab. 2014;16:305–316. [PubMed]

19. Miyan Z, Fawwad A, Sabir R, Basit A. Microbiological pattern of diabetic foot infections at a tertiary care center in a developing country. J Pak Med Assoc. 2017;67:665–669. [PubMed]

[20] Alexiadou K, Doupis J. Management of diabetic foot ulcers. Diabetes Ther [Internet]. 2012;3(1):4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22529027

[21] Mesa Perez JA, Vitarella G, Rosas Guzman J Guías ALAD de Pie Diabético. Rev ALAD. 2010;XVIII(2):73–85.

[22] Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, et al. The global burden of diabetic foot disease. Lancet. 2005;366(9498):1719–1724. [PubMed]

[23] Tirado RA del C, López JAF, Tirado FJ del C. Guía de práctica clínica en el pie diabético. Arch Med. 2014;10(1):1–17.

[24] Esquirol J, Vila H. Factor de crecimiento epidérmico, innovación y seguridad Factor de crecimiento epide. Med Clin. 2014;145(7).

[25] Gomez-Villa R, Aguilar-Rebolledo F, Lozano-Platonoff A, et al. Efficacy of intralesional recombinant human epidermal growth factor in diabetic foot ulcers in Mexican patients: A randomized double-blinded controlled trial. Wound Repair Regen. 2014;22(4):497–503. [PubMed]

26. Singh N, Armstrong DG, Lipsky BA.Preventi ng foot ulcers in patients with diabetes. JAMA. 2005;293:217-28.

27. Brem H, Sheehan P, Rosenberg HJ, Schneide r JS, Boulton AJ.Evidence-based protocol for diabetic foot ulcers. Plat Reconstr Surg. 2006;117:7 Suppl193S-209S.

28. International Diabetes Federation International Working Group on the Diabetic Foot. Available at: http://www.idf.org/webdata/docs/background_info_AFR.pdf. Accessed May 9, 2016.