Juniper Online Journal of
Orthopedic & Orthoplastic Surgery
ISSN: 2641-8266

Research Article
Volume 1 Issue 2 – May 2017
DOI: 10.19080/JOJOOS.2017.01.555559

JOJ Orthoped Ortho Surg
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Characterization of Most Common Bacterial Culture Isolates from Infected Diabetic Foot Tissue Specimens and Their Sensitivity to Antimicrobial Agents: A Survey of Patient Data from Three Tertiary Care Hospitals in Peshawar

Farhan Ullah[1], Syed Muhammad Adnan Shah*[2], Syed Shahmeer Raza[3], Syed Muhammad Salman Shah[3], Amer Kamal Hussain[3] and Muhammad Daniyal Nadeem[3]

[1]*Medical A Ward, Hayatabad Medical Complex, Pakistan*

[2]*Ayub Medical College Abbottabad, Pakistan*

[3]*Khyber Medical College, University of Peshawar, Pakistan*

Submission: August 07, 2017; **Published:** August 29, 2017

***Corresponding author:** Syed Muhammad Adnan Shah, Ayub Medical College Abbottabad, Abbottabad, KPK, Pakistan; Tel: 19293107646; Email: syed719@hotmail.com

Abstract

Objective: To find out the most common organisms responsible for Diabetic Foot Infection and their sensitivity to antimicrobial agents for the prevention of sepsis/amputation by the administration of empirical treatment.

Introduction: A diabetic foot is a non-healing ulcer due to the presence of diabetes in a patient. A "diabetic foot syndrome" is when several diabetic foot pathologies are present. The organism responsible for a Diabetic foot is clostridium species in the west [1], hence, we need to know the most common organism involved in DF in our setup. Our research project sheds light on the prevalence of most common organism responsible for diabetic infection and to find out their sensitivity to antimicrobial agents to prevent amputation and sepsis by the administration of empirical treatment.

Material and Methods: Study was carried out to analyze the bacterial isolates of all patients admitted to the

a) Medical and Endocrinology Ward of LADY READING HOSPITAL presented with diabetic foot infection.

b) Surgical (A, B, C, D, E), Medical (A, B, C, D, E) and Orthopedic ward of Khyber Teaching Hospital presented with diabetic foot infection.

c) Endocrinology and Surgical a ward of HAYATABAD MEDICAL COMPLEX, presented with diabetic foot infection, Wagner grade 2-5 from December 2014 to April 2105.

We started by formulating a questionnaire that was circulated among the designated groups of people, to check for organism responsible. Convenient sampling technique is used. A 5 months long prospective study (taking the midyear population into account) was carried out.100 patients having DFI (diabetic foot infection) were selected, their C/S (culture and sensitivity) reports were performed and analyzed using SPSS(Statistical Package for the Social Sciences)20.

Results: According to our findings a large number of people presenting with Diabetic Foot showed the following results: A total of 100 {62 aerobes (62%) and 38 others (fungal or anaerobes) (38%)} were isolated. This research work would hopefully give us deeper insights into further understanding, prevention and treatment of this disorder.

Conclusion: Our study design was prospective, *Staph. Aureus* and *E.coli* are the most common Gram positive and Gram negative organisms, respectively, in KPK. *E.coli* being the subset that mainly represents the bacterial population, isolated, upon culture, with high prevalence of antimicrobial drug resistance particularly to Augmentin, cephradine, ciprofloxacin, cefotaxime and cefpodoxime and sensitive to Cefoperazone/Sulbactam (94.4%), Vancomycin (92.3%), Imipenem (89.4%) and Piperacillin/Tazobactam (89.4%).

Introduction

A diabetic foot is a non-healing ulcer due to the presence of diabetes in a patient. [2]

The most important and serious foot complications in diabetes are:

a) Ulceration (an estimate shows lifetime incidence of foot ulcers among people affected by diabetes is around 15-25%) "A Diabetic foot ulcer (DFU) affects around 15% of all the people suffering from diabetes along the course of their life and is a major factor in predisposing amputations in almost 15% of all cases [3-6].

b) Neuropathic osteoarthropathy.

These are the significant risk factors for lower extremity amputation.

Administration of antimicrobial agents, to which they are sensitive to, is very important part of the management of these patients. "Of all the methods that are proposed for the prevention of DFU, the only beneficial therapy in RCTs was foot temperature-guided avoidance therapy "a meta-analysis shows [7].

Treating DFIs with broad spectrum antibiotics is practiced worldwide; however, because of infections with resistant organisms, treating with a narrow spectrum antibiotic may be more appropriate, due to low resistance rates and high bacteriological and clinical cure rates. The fact that antibiotic sensitivity changes with time [8,9], therefore knowledge of common bacteria involved and their current sensitivity pattern will help us not only in providing the best initial empirical therapy but also in preventing the emergence of resistance [10] when taken properly and to prevent long term morbidity. Records of 2013 show that around 382 million people worldwide suffer from diabetes [11]. About 90% of these are type 2 [12,13]. International Diabetes Federation (IDF) in 2014 audited that diabetes resulted in 4.9 million deaths [14]. World Health Organization (WHO) in 2012 estimated that diabetes resulted in 1.5 million deaths, what makes it the 8th leading cause of death [15]. Modeling is used by IDF to estimate the deaths amounting to diabetes [16]. Low and middle-income countries amounted for around 80% deaths due to diabetes [17]. Within this backdrop we propose to study the most common organisms responsible for Diabetic Foot Infection and their sensitivity to antimicrobial agents for the prevention of sepsis/amputation by the administration of empirical treatment.

Material and Methods

This study was carried out at the 3 major Tertiary care hospitals of the province which receives patients from across the province. Convenient sampling technique was used and the sample size was calculated to be 100 using WHO sample size calculator. Patients who were resident of KPK and were admitted to KTH, HMC or LRH for diabetic foot treatment were included in the study and those who refused to participate in the study, patients with documented anatomical abnormalities of lower limbs (based on history and past medical record) and those without a confirm diagnosis of diabetes were excluded from the study.

Diabetes was defined as symptoms of diabetes plus random blood sugar ≥ 11.1 mmol/ L or fasting blood sugar ≥ 7mmol/L and/or HbA1c ≥ 6.5% [18]. A semi structured questionnaire was used for this purpose having open-ended as well as close-ended questions. In most cases data was collected by person to person interviews with respondents. Study was conducted after approval from ethical & research committee.

Results

This section revolves around meaningful facts and figures derived computational statistics of our research work. Our sample size was 100 people belonging to different walks of life with different occupations. 58 were males and 42 were females. Marital status: 64 were married, 14 were single, 12 were divorced and 10 were widowed. If we talk about their educational background then 37 were uneducated, 26 studied up to primary, 17 were matriculate and 20 had done higher education. Demographically, out of the 100 there were 24 from Peshawar region, 5 from DI Khan, 6 each from Chitral and Charsadda, 7 from Nowshera, 8 from Kohat, 9 from Bannu, 10 each from Sawabi and Sawat, 15 from FATA.

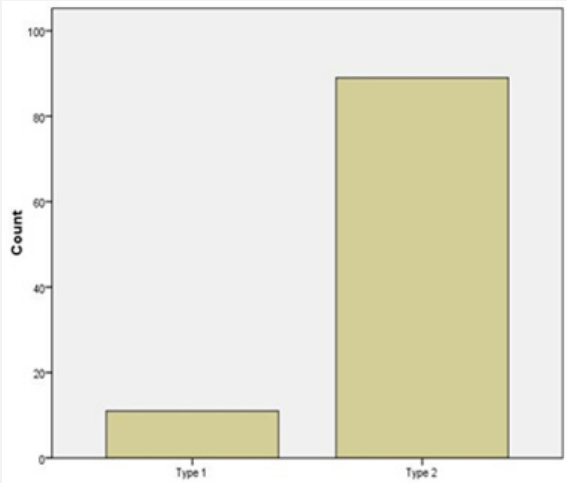

Figure 1: Types of diabetes.

Occupationally, out of 100 there were 8 who were students, 8 others were self-employed, 10 were unemployed, 38 were employed, 36 were house workers. 87 presented with Type 2 diabetes and 13 presented with Type 1diabetes 90 (Figure 1). Amputation: 35 had no amputation, 35 with amputation below ankle, 16 with below knee amputation and 14 with above knee amputation (Figures 2 & 3).

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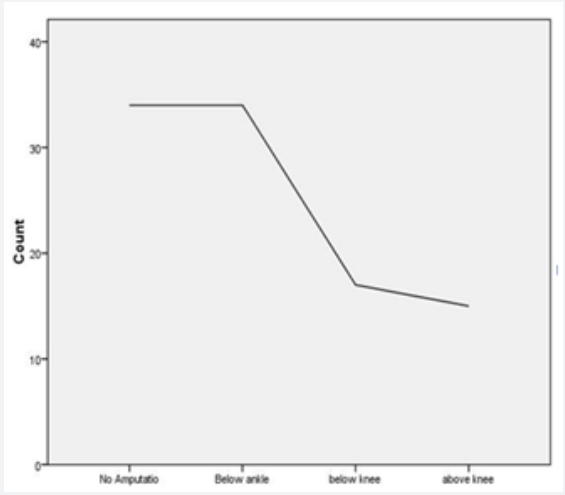

Figure 2: Amputation.

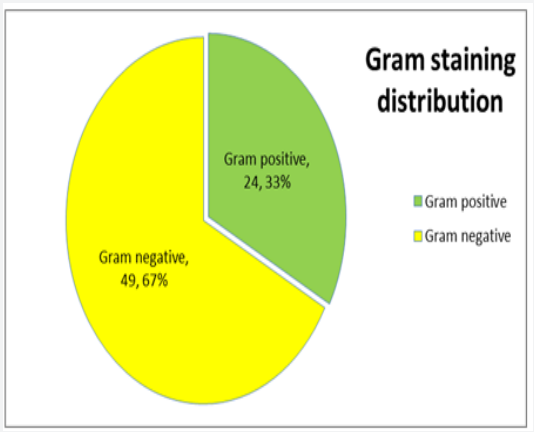

Figure 3: Gram staining distribution

1. Gram positive 47 (75.8%);
2. Gram negative 15(24.2%).

Table 1:

organisms	Frequency	Percent	Valid Percent	Cumulative Percent
no orgaism	36	36.0	36.0	36.0
E.coli	19	19.0	19.0	55.0
staph aureus	9	9.0	9.0	64.0
MRSA	6	6.0	6.0	70.0
Proteus mirabilis	4	4.0	4.0	74.0
Citrobacter freundii	1	1.0	1.0	75.0
Klebsiella	1	1.0	1.0	76.0
Pseudomonas	7	7.0	7.0	83.0
Acinobacter	2	2.0	2.0	85.0
Coliform species	4	4.0	4.0	89.0
Proteus vulgaris	2	2.0	2.0	
91.0				
MRSA + E.coli	5	5.0	5.0	96.0
MRSA + pseudomonas	1	1.0	1.0	97.0
staph aureus + coliform species	3	3.0	3.0	100.0
Total	100	100.0	100.0	

a) The three most frequently found Aerobic bacteria *E.coli* (19%), *Staph. Aureus* (9%), *Pseudomonas* (7%) (Table 1).

b) The most frequently found Gram positive bacteria are *Staph. Aureus* (9%), MRSA (6%). The most common Gram negative bacteria are *E.coli* (19%), *Pseudomonas* (7%), and Proteus (4%).

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Table 2:

Drugs		Organism													
		E.coli	*staph aureus*	*MRSA*	*Proteus mirabilis*	*Citrobacter freundii*	*Klebsiella*	*Pseudomonas*	*Acinobacter*	*Coliform species*	*Proteus vulgaris*	MRSA + *E.coli*	MRSA + pseudomonas	*staph aureus* + coliform species	Total
piperacillin_tazobactam	Resistant	2	0	6	0	1	0	0	2	1	0	5	1	2	20
azobactam	Sensitive	17	7	0	4	0	1	7	0	3	2	0	0	0	41
Total		19	7	6	4	1	1	7	2	4	2	5	1	2	61
Percentage	Resistant	10.5%	0%	100%	0%	100%	0%	0%	100%	25%	0%	100%	100%	100%	32.8%
	Sensitive	89.5%	100%	0%	100%	0%	100%	100%			100%	0%	O%	0%	67.2%
Amoxicillin	Resistant	9	3	5	2	1	0	1	2	1	2	4		2	32
	Sensitive	4	4	0	1	0	1	2	0	2	0	0		1	15
Total		13	7	5	3	1	1	3	2	3	2	4		3	47
Percentage	Resistant	69.2%	42.8%	100%	66.6%	100%	0%	33%	100%	33%	100%	100%		66%	68%
	Sensitive	30.7%	57.2%	0%	33.33%	0%	1005	66%	0%	66%	0%	0%		33%	32%
Augmentin	Resistant	16	2	6	1	1	1	6	2	2	1	5	1	2	46
	Sensitive	0	7	0	3	0	0	1	0	2	1	0	0	1	15
Total		16	9	6	4	1	1	7	2	4	2	5	1	3	61
Percentage	Resistant	100%	22.2%	100%	25%	100%	100%	85.8%	100%	50%	50%	100%	100%	66%	75.4%
	Sensitive	0%	77.8%	0%	75%	0%	0%	14.2%	0%	50%	50%	0%	0%	33%	24.6%
Cepherdine	Resistant	13	0	6	2	1	1	4	2	4	2	4	1	2	42
	Sensitive	6	8	0	2	0	0	3	0	0	0	0	0	1	20
Total		19	8	6	4	1	1	7	2	4	2	4	1	3	62
Percentage	Resistant	68.4%	0%	100%	50%	100%	100%	57.1%	100%	100%	100%	4%	100%	66%	67.8%
	Sensitive	31.65	100%	0%	50%	0%	0%	42.9%	0%	0%	0%	0%	0%	33%	32.2%
Cefuroxime	resistance	12	0	3	2	1	1	4	2	4	2	3		2	36
	Sensitive	6	7	0	2	0	0	3	0	0	0	0		0	18
Total		18	7	3	4	1	1	7	2	4	2	3		2	54
Percentage	Resistant	66%	0%	100%	50%	100%	100%	57.1%	100%	100%	100%	100%		100%	66%
	Sensitive	33%	100%	0%	50%	0%	0%	42,9%	0%	0%	0%	0%		0%	33%
Cephtriaxone	Resistance	11	0	5	0	1	1	4	2	2	2	5	1	2	36
	Sensitive	7	9	0	4	0	0	3	0	2	0	0	0	1	26
Total		18	9	5	4	1	1	7	2	4	2	5	1	3	62
Percentage	Resistant	61.1%	0%	100%	0%	100%	100%	57.1%	100%	50%	100%	100%	100%	66%	58%
	Sensitive	38.9%	100%	0%	100%	0%	0%	42.9%	0%	50%	0%	0%	0%	33%	42%

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Cefut-oxime	Resistance	13	0	6	0	1	1	4	2	2	2	3	1	2	37
	Sensitive	5	9	0	4	0	0	3	0	2	0	0	0	1	24
Total		18	9	6	4	1	1	7	2	4	2	3	1	3	61
Perc-entage	Resistant	72.2%	0%	100%	0%	100%	100%	57.1%	100%	50%	100%	100%	100%	66%	60.6%
	Sensitive	27.8%	100%	0%	100%	0%	0%	42.9%	0%	50%	0%	0%	0%	33%	39.4%
Cefpod-oxime	Resistance	12	0	3	0	1	1	3	2	2	2	3		2	31
	Sensitive	7	8	0	4	0	0	4	0	1	0	0		0	24
Total		19	8	3	4	1	1	7	2	3	2	3		2	55
Perc-entage	Resistant	63.1%	0%	100%	O%	100%	100%	42.9%	100%	66%	100%	100%		100%	56.4%
	Sensitive	36.9%	100%	0%	100%	0%	0%	57.1%	0%	33%	0%	0%		0%	43.6%
Cefepime	Resistane	10	0	3	0	1	1	3	2	2	2	3		2	29
	Sensitive	7	7	0	4	0	0	4	0	1	0	0		0	23
Total		17	7	3	4	1	1	7	2	3	2	3		2	52
Perc-entage	Resistant	58.8%	0%	100%	0%	100%	100%	42.9%	100%	66%	100%	100%		100%	55.8%
	Sensitive	41.2%	100%	0%	100%	0%	0%	57.1%	0%	33%		0%		0%	44.2%
Cefo-perazone/ sulbactam	Resistant	1	0	2	0	1	1	3	1	2	0	3		2	16
	Sensitive	17	7	0	4	0	0	4	1	2	2	0		0	37
Total		18	7	2	4	1	1	7	2	4	2	3		2	53
Perc-entage	Resistant	5.6%	0%	100%	0%	100%	100%	42.9%	50%	50%	0%	100%		100%	30.2%
	Sensitive	94.4%	100%	0%	100%	0%	0%	57.1%	50%	50%	100%	0%		0%	69.8%
Poly-mixin-B	Resistane	3	0	1	0	0	0	2	1	2	1	3		2	15
	Sensitive	10	7	0	3	1	1	4	1	2	0	0		0	29
Total		13	7	1	3	1	1	6	2	4	1	3		2	44
Perc-entage	Resistant	23.1%	0%	100%	0%	0%	0%	33%	50%	50%	100%	100%		100%	34%
	Sensitive	76.9%	100%	0%	100%	100%	100%	66%	50%	50%	0%	0%		0%	66%
Colestin	Resistane	2	0	1	0	0	0	1	1	1		3		2	11
	Sensitive	11	7	0	3	1	1	4	1	2		0		0	30
Total		13	7	1	3	1	1	5	2	3		3		2	41
Perc-entage	Resistant	15.4%	0%	100%	0%	0%	0%	20%	50%	33%		100%		100%	26.8%
	Sensitive	84.6%	100%	0%	100%	100%	100%	80%	50%	66%		0%		0%	73.2%
Cotrim-oxazole	Resistane	9	4	2	3	1	1	2	2	2		5	1	2	34
	Sensitive	4	4	3	1	0	0	3	0	1		0	0	1	17
Total		13	8	5	4	1	1	5	2	3		5	1	3	51
Perc-entage	Resistant	69.2%	50%	40%	75%	100%	100%	40%	100%	66%		100%	100%	66%	66.7%
	Sensitive	30.7%	50%	60%	25%	0%	0%	60%	0%	33%		0%	0%	33%	33.3%
Chlora-mphenicol	Resistane	5	1	0	0	1	0	2	2	2		1	0	1	15
	Sensitive	8	8	6	3	0	1	3	0	2		4	1	2	38

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Total		13	9	6	3	1	1	5	2	4		5	1	3	53
Perc-entage	Resistant	38.4%	11.1%	0%	0%	100%	0%	40%	100%	50%		20%	0%	33%	28.3%
	Sensitive	61.5%	88.9%	100%	100%	0%	100%	60%	0%	50%		80%	100%	66%	71.7%
Doxy-cycline	Resistane	5	2	0	1	1	0	1	2	3		2	0	1	18
	Sensitive	7	6	6	2	0	1	4	0	0		2	1	2	31
Total		12	8	6	3	1	1	5	2	3		4	1	3	49
Perc-entage	Resistant	41.7%	25%	0%	33%	100%	0%	20%	100%	100%		50%	0%	33%	36.7%
	Sensitive	58.3%	75%	100%	66%	0%	100%	80%	0%	0%		50%	100%	66%	63.3%
Mino-cycline	Resistane	4	2	0	1	1	0	1	2	2		2	0	1	16
	Sensitive	7	6	6	2	0	1	4	0	0		2	1	2	31
total		11	8	6	3	1	1	5	2	2		4	1	3	47
Perc entage	Resistant	36.4%	25%	0%	33%	100%	0%	20%	100%	100%		50%	0%	33%	34%
	Sensitive	63.6%	75%	100%	66%	0%	100%	80%	0%	0%		50%	100%	66%	66%
Cipro-floxacin	Resistane	13	3	2	0	1	0	4	2	2	0	4	1	3	35
	Sensitive	5	6	0	3	0	1	3	0	2	2	0	0	0	22
Total		18	9	2	3	1	1	7	2	4	2	4	1	3	57
Perc-entage	Resistant	72.2%	33%	100%	0%	100%	0%	57.1%	100%	50%	0%	100%	100%	100%	61.4%
	Sensitive	27.8%	66%	0%	100%	0%	100%	42.9%	0%	50%	100%	0%	0%	0%	38.6%
Levo-floxacin	Resistane	9	1	2	0	1	0	4	2	2	0	4	1	3	29
	Sensitive	9	7	0	4	0	1	3	0	2	1	0	0	0	27
Total		18	8	2	4	1	1	7	2	4	1	4	1	3	56
Perc-entage	Resistant	50%	12.5%	100%	0%	100%	0%	57.1%	100%	50%	0%	100%	100%	100%	51.8%
	Sensitive	50%	87.5%	0%	100%	0%	100%	42.9%	0%	50%	100%	0%	0%	0%	48.2%
Tegicyclin	Resistane	1	0	1	0	1	0	1	2	0	0	3		2	11
	Sensitive	15	8	3	3	0	1	3	0	2	2	2		1	40
Total		16	8	4	3	1	1	4	2	2	2	5		3	51
Perc-entage	Resistant	6.3%	0%	25%	0%	100%	0%	25%	100%	0%	0%	60%		66%	21.6%
	Sensitive	93.7%	100%	75%	100%	0%	100%	75%	0%	100%	100%	40%		33%	78.4%
Amikacin	Resistant	2	2	0	0	1	0	3	1	2	1	2		0	14
	Sensitive	16	5	1	4	0	1	4	1	2	0	2		2	38
Total		18	7	1	4	1	1	7	2	4	1	4		2	52
Perc-entage	Resistant	11.1%	71.4%	0%	0%	100%	0%	42.9%	50%	50%	100%	50%		0%	26.9%
	Sensitive	88.9%	28.6%	100%	100%	0%	100%	57.1%	50%	50%	0%	50%		100%	73.1%
Imi-penem	Resistant	2	0	5	0	1	0	2	2	1	0	5		2	20
	Sensitive	17	7	0	3	0	1	5	0	3	2	0		0	38
Total		19	7	5	3	1	1	7	2	4	2	5		2	58
Perc-entage	Resistant	10.5%	0%	100%	0%	100%	0%	28.6%	100%	25%	0%	100%		100%	34.5%
	Sensitive	89.5%	100%	0%	100%	0%	100%	71.4%	0%	75%	100%	0%		0%	65.5%

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Van-comycin	Resistant	1	0	0	0	1	0	1	1	0	0	0	0	1	5
	Sensitive	12	7	6	3	0	1	3	1	1	1	5	1	1	42
Total		13	7	6	3	1	1	4	2	1	1	5	1	2	47
Per-centage	Resistant	7.7%	0%	0%	0%	100%	0%	25%	50%	0%	0%	0%	0%	50%	10.6%
	Sensitive	92.3%	100%	100%	100%	0%	100%	75%	50%	100%	100%	100%	100%	50%	89.4%
Fusidic acid	Resistant	1	1	0	0	1	0	1	1	0	0	1	0	2	8
	Sensitive	12	7	4	3	0	1	3	1	1	1	4	1	1	39
Total		13	8	4	3	1	1	4	2	1	1	5	1	3	47
Perc-entage	Resistant	7.7%	12.5%	0%	0%	100%	0%	25%	50%	0%	0%	20%	0%	66%	17%
	Sensitive	92.3%	87.5%	100%	100%	0%	100%	75%	50%	100%	100%	80%	100%	33%	83%

c) Most effective drugs against Gram positive are Cephalosporin's {Generation ll and lll (100%)}, Vancomycin (100%), Imipenem (100%), piperacillin/Tazobactam (100%) (Table 2).

d) Most effective drugs against Gram negative are Cefoperazone/Sulbactam (94.4%), Vancomycin (92.3%), Imipenem (89.4%), and Piperacillin/Tazobactam (89.4%).

e) Most effective drugs against MRSA are Vancomycin (100%), Chloramphenicol (100%), Amikacin (100%), and Minocycline (100%).

f) Most effective drug against polymicrobial infection is Vancomycin (100%), Chloramphenicol (80%), and amikacin (50%).

Conclusion

a) *Staph. Aureus* and *E.coli* are the most common Gram positive and Gram negative organisms, respectively, in KPK.

b) Anaerobes are still the most common cause for this infection, although the prevalence is less.

c) These ulcers and infections may require use of combined antimicrobial therapy for initial management, repeated dressing and wound debridement may be required.

d) This study helps us to choose empirical treatment for patients with diabetic foot infection and also in the management of patient who comes with sepsis that is caused from diabetic foot.

Recommendations

From our study, we can concoct the following recommendations which show us the most common organism involved in the diabetic foot and help us in preventing the amputation and sepsis.

Since the most common organism appears to be *E.coli* and it is most sensitive to drugs such as;

i. Cefoperazone/Sulbactam (94.4%)

ii. Vancomycin (92.3%)

iii. Imipenem (89.4%)

iv. piperacillin/Tazobactam (89.4%)

a) Therefore, patients presenting with diabetic foot should be directly put on empirical treatment, to prevent further damage to the body and better recovery.

b) The patients should be educated to keep their feet clean and healthy.

c) The attendants of the patients should be advised to take proper care of their patient.

d) The patient should be compelled to check their limbs specially, lower extremities for any ulcers, wounds or cuts.

e) Good compliance to therapy will yield positive results and would eradicate the complications before it causes further damage to health.

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How to cite this article: Farhan U, Syed M A S, Syed S R, Syed M S S, Amer K H, et. al. Characterization of Most Common Bacterial Culture Isolates from Infected Diabetic Foot Tissue Specimens and Their Sensitivity to Antimicrobial Agents: A Survey of Patient Data from Three Tertiary Care Hospitals in Peshawar. JOJ Orthoped Ortho Surg. 2017; 1(2) : 555559. DOI: 10.19080/JOJOOS.2017.01.555559

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DOI: 10.19080/JOJOOS.2017.01.555559

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How to cite this article: Farhan U, Syed M A S, Syed S R, Syed M S S, Amer K H, et. al. Characterization of Most Common Bacterial Culture Isolates from Infected Diabetic Foot Tissue Specimens and Their Sensitivity to Antimicrobial Agents: A Survey of Patient Data from Three Tertiary Care Hospitals in Peshawar. JOJ Orthoped Ortho Surg. 2017; 1(2) : 555559. DOI: 10.19080/JOJOOS.2017.01.555559