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RISK FACTORS FOR MULTI-DRUG RESISTANT ORGANISMS IN DIABETIC FOOT ULCER: IMPACT OF GLYCEMIC CONTROL ON WOUND HEALING

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ABSTRACT

Background: Diabetic foot Ulcer is one of most significant and devastating complications of Diabetes. To study risk factors for multi-drug resistant organisms in Diabetic foot ulcer; impact of Glycemic control on wound healing using Chi square test, student's t test logistic regression analysis. Methods: In 100 patients hospitalized, microbiological specimens taken on admission. Potential risk factors for MDRO-positive specimens were examined using univariate analyses, logistic regression for MDRO presence and wound healing time. Prospective follow-up data from patients used to evaluate the influence of MDRO infection& glycemic control on time to healing. Results: MDRO were isolated in 75 of 100 patients. Poor glycemic control, previous hospitalization, history of amputation, history of antibiotic use, ulcer size, necrotic ulcer, recurrent ulcers, higher grade of ulcer and polymicrobial culture were associated with MDRO infected foot ulcers ($p < 0.1$). MDRO has no impact on wound healing. Logistic regression analysis indicated higher Grade of ulcer, poor glycemic control significantly delayed wound healing. Conclusions: The prevalence of MDRO is alarmingly high. Higher grade ulcers & recurrent ulcers are more prone to acquire MDROs. Positive MDRO status is not associated with wound healing. Higher grade of ulcer & poor glycemic control delays healing of foot ulcer.

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INTRODUCTION

Diabetes mellitus is a chronic disease with chronic microvascular and macrovascular complications.[1] Diabetic foot is often quite a dreaded disability, with long stretches of hospitalization, impossible, mounting expenses, with the ever dangling end result of an amputated limb. The phantom limb plays its own cruel joke on the already demoralized psyche [2] The diabetic foot, no wonder, is one of the most feared complications of diabetes. [3, 4] Diabetic foot ulcer (DFU) cause significant health problems which reduce the patient's quality of life, cause lower limb amputation, increase morbidity and increase the cost of health services.

Infection with multidrug resistant organisms will increase the morbidity; patient related factors also play an important role in the development of such organisms**.[5]** Diabetes is one such factor and its complication such as foot ulcer harbors MDRO.[6] There are various other factors involved in the emergence of MDRO in diabetic foot ulcers.[7] Diabetic foot ulcer is one of the most significant and devastating complications of diabetes while the factors such as poor glycemic control in Diabetes, longer course of disease exist.[8] Risk factors for diabetic foot ulcer include poor glycemic control, previous foot ulcerations, amputations. Poor glycemic control has long been recognized to increase risk of diabetic complications particularly diabetic foot disease. [9]

MDRO are defined as microorganisms that are resistant to two or more classes of antimicrobial agents. Common organisms isolated are gram-positive organisms such as *Staphylococcus aureus, Enterococcus* and gram-negative bacteria such as *Pseudomonas aeruginosa, Escherichia coli,Klebsiella*species. *Proteus* species, sometimes these organisms shows polymicrobial infection according to it the treatment also varies. [10] At present, there is a paucity of data on extended spectrum beta-lactamase (ESBL)-producing organisms, methicillin resistant *Staphylococcus aureus* (MRSA) from DFU.[11] 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.Thereafter appropriate suitable antibiotic in full doses for full course should be instituted for the treatment of infection to prevent the development of antibiotic resistance.[12]

Glycemic control has a number of deleterious effects on the body. Glycemic control plays a pivotal role in the genesis of diabetic foot ulcers, in its recurrence, chronicity, and worsening of diabetic foot ulcers and eventually contributing to amputations. [13] Glycemic control in a patient with diabetic foot ulcer is of paramount importance because it can predispose to new infections, delayed wound healing and spreading of existing infections. In fact, foot infections are common in patients with diabetes and are associated with high morbidity and risk of lower extremity amputation. Glycemic control has been enunciated as the foremost principle in effective management of diabetic foot ulcers and preventing amputations. [14]

The present study was an attempt to correlate the risk factors and their association with the development of MDRO in Diabetic foot ulcers and the impact of Glycemic control on wound healing in Diabetic foot ulcers , evaluate the different microorganisms infecting the DFU and to know the antibiotic susceptibility patterns to the isolates.

Methodology:

100 diabetic patients with foot ulcer were prospectively studied for a period of 6 months in Department of Surgery. This study has been approved by the Institutional Ethical Committee. A detailed history, general physical examination was taken and proforma regarding risk factors for MDRO were filled up. Written consent was obtained from all subjects in the study. The microbiological profile was analyzed.

Microbiological study:

The wound swab was taken after superficial debridement to avoid colonizer using sterile swabs introduced deep into the wound.

Grading of wound is:

1. involving ligament,tendon,orfascia without abscess/osteomyelitis
2. Grade 3 wound – deep Grade 1 wound – superficial ulcer
3. Grade 2 wound – ulcer ulcer with abscess/osteomyelitis
4. Grade 4 wound – gangrene of a part of foot
5. Grade 5 wound- whole foot gangrene [15]

Wound swabs were taken and transported immediately. Standard microbiological procedures were to be performed for all swabs to isolate the pathogenic bacteria. Antimicrobial susceptibility was performed and MRSA was defined according to it. [16]

Detection of extended spectrum beta-lactamase:

Detection of extended spectrum beta-lactamase was done. The presumptive ESBL production was confirmed. In addition we attempted to identify risk factors for association of diabetic foot ulcer and MDRO. Using internationally accepted criteria, the multidrug resistant organisms were identified. Infected ulcers were grouped into those with MDRO and those without MDRO and were then compared using univariate analysis. In order to identify the risk factor, for the presence of MDRO, analysis by logistic regression was done. Each patient was followed for a period of ten weeks to assess the status of wound healing. The impact of MDRO was assessed by analyzing the associations of amputations, duration of hospital stay,status of wound at ten weeks with MDRO infected ulcers and influence of other factors on wound healing using appropriate statistical tools.[17]

Detection of AmpC:

Presumptive test for inducible Amp C β-lactamases was considered done. [18]

Statistical analysis

Baseline characteristics and changes in these variables among all subjects are presented as mean values (with 95% confidence intervals [CIs]) or as percentages. The significance of differences between variables was examined using *t*-tests for continuous variables or the Chi-squared test for categorical variables.

Risk factors of incident diabetes at the follow-up were first analyzed individually using logistic regression analysis. Multiple logistic regression models were constructed by stepwise and backward elimination algorithms. These models were adjusted for age, sex, BMI, hypertension, hyperlipidemia, stroke, CHD, kidney disease, occupation, illiteracy, a history of smoking and drinking, and IPAQ scores, and fall history.

The final predictive factors for diabetes chosen by multiple logistic regression analysis were evaluated using receiver operating characteristic (ROC) curve analysis. The optimal cut-off points for these predictive factors were calculated using the Youden index.

Differences were considered significant at two-tailed $P < 0.05$. All statistical analyses were performed using SPSS version 21.0.

RESULTS

MDRO were isolated from 75 patients of 100 (75%). 61.33% (92 out of 150) of isolated organisms were MDRO. Majority of the patients in our study had recurrent and higher grade of ulcers (Wagner's grade II or worse) analysis by Logistic regression indicated that, only two factors significantly increased the risk of acquiring MDRO infection: Recurrent ulcer and higher grade of ulcers. Age and higher Grade of ulcer, poor glycemic control significantly delayed wound healing.

Microbial observations:

A total of 150 organisms were isolated from 100 patients. On an average 1.56 species were isolated from each patient. 56% of patients (56 of the 100 patients) had polymicrobial culture. Among the isolates, most were gram negative rods (64.65 %) and almost all the rest were gram positive cocci. There was a solitary gram negative coccus. Among the isolates, Escherichia coli was the most common one constituting 28%, followed by Staphylococcus aureus 26 %, followed by Pseudomonas aureginosa 18.7% (Table 1).

As stated earlier, the frequency distribution of patients with multidrug resistant organisms among the 100 patients included in the study, was 75%, being observed in 75 out of 100 patients. 61.33% (92 out of 150) of isolated organisms were multidrug resistant organisms. Antibiotic resistance was observed in 75.26% (73 out 97) of gram negative organisms compared to 35.84% (19 out of 53) in gram positive organisms. Among the gram positive cocci, 58.33% of Enterococcus faecalis species and 30.76 % of Staphylococcus auerus species were multidrug resistant. Among the gram negative bacilli, multidrug resistance was noted in 85.71 of Escherichia coli, 87.1%of Pseudomonas aeuroginosa, 75% of klebsiella species and 60% of proteus mirabilis, with lower percentages in other isolates. Listing the multidrug resistant organisms isolated, ESBL Escherichia coli was found to be highest (36/88) followed by MDR Pseudomonas aeruginosa (24/88)(Table 2 and 3).

MDRO versus non MDRO infected ulcerations:

Results of the univariate analysis comparing patients with MDRO-infected ulcers versus patients with non-MDRO-infected ulcers showed a statistically significant difference for some factors by Chi-square test, Student's test. Results showed, poor glycemic control, previous hospitalization, previous history of amputation, previous antibiotic usage, size of ulcer, necrotic ulcer, recurrent ulcers, higher grade of ulcer and polymicrobial culture, were significantly associated with MDRO infected foot ulcers (Table 4).

Impact of MDRO on wound healing:

IMPACT OF MDROs:

The mean duration of hospital stay in MDRO infections was 15.18 days and that of no MDRO infections were 10.34 days. The difference was statistically significant (table 6).

Influence of glycemic control on wound healing:

Poor glycemic control significantly ($p<0.1$) associated with poor healing of the ulcer.

MDROs & Amputations :

Presence of multi drug resistant organisms in the foot ulcers was associated with statistically significant increased frequency of amputations, both major and minor ($p < 0.01$). In the MDRO group 37 % of patients had some form of amputations, where as in non-MDRO group only 2 % of the patients had amputations (Table 7).

Based on the status of the ulcer at 10 weeks time the patients were grouped as healed andnon-healed group. Healed group included the patients whose ulcers were completely healed and reduced in size. The rest were in the non-healed group. 44 patients were in healed group and 56 were in the non-healed group.

By univariate analysis, nature of ulcer, recurrent ulcer, grade of ulcer site of ulcer, culture, size of the ulcer, the glycemic control were significantly ($p < 0.1$) associated with poor healing of the ulcer (Table 8 and 9).

Table 1: Distribution of isolated micro organisms.

VARIABLE	NO.OF ORGANISMS	PERCENTAGE OF ISOLATED ORGANISMS	PERCENTAGE OF CASES
Microorganisms			
Gram-positive cocci			
Streptococcus species	2	1.33%	2%
Staphylococcus aureus	39	26%	39%
Enterococcus. Species	12	8%	12%
Total	**53**	**35.33%**	
Gram-negative rods			
Acinetobacter species	7	4.7%	7%
Citrobacter species	5	3.3%	5%
Enterobacter species	4	2.7%	4%
E.coli	42	28%	42%
Klebsiellapneumonia	4	2.7%	4%
Proteus vulgaris	2	1.3%	2%
Proteus mirabilis	5	3.3%	5%
Pseudomonas aeruginosa	28	18.7%	28%
Total	**97**	**64.65%**	
Grand total	**150**	**100%**	

Table 2: Frequency distribution of multi drug resistant micro organisms.

VARIABLE	NO.OF ORGANISMS	PERCENTAGE OF MDRO	PERCENTAGE OF ULCERS WITH MDRO
Microorgansims			
Gram-positive cocci			
Streptococcus.species	2 (1.33%)		
Staphylococcus aureus	39 (26%)	12 (30.76%)	12%
Enterococcus. Species	12 (8%)	7 (58.33%)	7%
Gram-negative rods			
Acinetobacter species	7 (4.7%)	3 (42.86%)	3%
Citrobacter species	5 (3.3%)	1 (20%)	1%
Enterobacter species	4 (2.7%)	2 (50%)	2%
E.coli	42 (28%)	36 (85.71%)	36%
Klebsiellapneumoniae	4 (2.7%)	3 (75%)	3%
Proteus vulgaris	2 (1.3%)	1 (50%)	1%
Proteus mirabilis	5 (3.3%)	3 (60%)	3%
Pseudomonas aeruginosa	28 (18.7%)	24 (85.71%)	24%
Grand total	**150 (100%)**	**92(61.34%)**	

Table 3: List of multi-drug resistant microorganisms.

Variable	No. of organisms	Percentage
MICROORGANSIMS		
GRAM-POSITIVE COCCI		
Staphylococcus aureus (MRSA)	11	7.3%
Staphylococcus aureus (MRCONS)	9	6%
MDR Enterococcus species	4	2.7%
GRAM-NEGATIVE RODS		
MDR Acinetobacter species	4	2.7%
MDR Citrobacter species	3	2%
AMPC Enterobacter species	2	1.3%
E.coli(ESBL)	23	15.3%
E.coli (ESBL+ AMPC)	8	5.3%
Klebsiellapneumonia (ESBL)	5	3.3%
Proteus mirabilis (AMPC)	1	0.7%
Proteus mirabilis(ESBL)	3	2%
MDR Pseudomonas aeruginosa	19	12.7%
GRAND TOTAL	**92**	**61.34%**

TABLE 4: MDRO VS NON-MDRO.

VARIABLE	NMDRO	MDRO	TOTAL	X^2	P VALUE
Age (years)					
<40	1	2	3		
41-50	7	4	11	5.05	0.28
51-60	12	29	41		
61-70	14	26	40		
>70	1	4	5		
Sex					
Male	25	52	77	0.94	0.33
Female	10	23	33		
Socio eco-status					
Class 1	10	21	31		
Class 2	17	28	45		
Class 3	8	14	22	0.42	0.94
Class 4	1	1	2		
Class 5	0	0	0		
Duration of diabetes (years)					
<5	14	28	42		
5-10	13	20	33		
10-15	6	9	15	2.47	0.96
15-20	1	7	8		
>20	1	1	2		
Duration of ulcer (months)					
<1 month	24	47	71		
1-2 months	8	14	22		
2-3 months	3	0	3	7.79	0.05
3-4 months	0	4	4		
Depth of ulcer					
Superficial	16	35	51	9.29	0.01
Deep	19	30	49		
Nature of the ulcer					
Necrotic	4	42	46	29.28	0.00
Non necrotic	33	21	54		
Recurrence					
Recurrent	29	26	55	15.88	0.00
Non Recurrent	6	39	45		
Grade of ulcer					
Grade 1	10	1	11		
Grade 2	20	8	28	48.16	0.00
Grade 3	2	28	30		
Grade 4	3	23	26		
Grade 5	0	5	5		
Size of ulcer(cm^2)					
<4 cm^2	4	3	7		
4-8 cm^2	12	21	33		
8-16cm^2	14	24	38	3.07	0.55
16-24 cm^2	4	13	17		
>24 cm^2	0	5	5		
Glycemic control (hba1c)					
6-7%	6	11	17		
7-8%	18	19	37	9.29	0.01
>8%	7	35	42		
Bacteriology overview					
Mono microbial	21	23	44		
Poly microbial	14	42	56	5.59	0.01
Site of ulcer					
Plantar	4	3	7		
Margins	6	9	15		
Heels	9	18	27	3.02	0.80
Digits	8	18	26		

Malleoli	5	10	15		
Leg	3	5	8		
Multiple areas	0	2	2		
Smoking					
Smoker	19	30	49	0.60	0.44
Non-Smoker	16	35	51		
Alcohol					
Alcoholic	14	32	46	0.78	0.38
Non-Alcoholic	21	33	54		

Table 5: Logistic regression: MDRO VS Non-MDRO.

	B	S.E	Wald	df	Sig.	Exp(B)	95% C.i for EXP(B)	
							Lower	Upper
Age	.001	.036	.000	1	.986	1.001	.933	1.073
Nature	.965	.961	1.008	1	.315	2.624	.399	17.260
Recurrence	.888	.709	1.567	1	.211	2.430	.605	9.761
Grade	1.263	.517	5.966	1	.015	3.536	1.283	9.744
hba1c	.682	.461	2.187	1	.139	1.978	.801	4.883
Prev hospitalization	.599	.865	.479	1	.489	1.820	.334	9.919
Prev amputation	1.721	1.119	2.366	1	.124	5.587	.624	50.037
Site	.153	.250	.376	1	.540	1.166	.714	1.902
Prev antibiotics	-.273	.882	.096	1	.756	.761	.135	4.283
Culture	.720	.686	1.103	1	.294	2.055	.536	7.886
constant	-7.902	2.911	7.368	1	.007	.000		

Table 6: Mean duration of hospital stay.

	MDRO	N	Mean	Std.deviation	Std.error Mean	t value	P value
Stay	NMDRO	35	10.34	8.51	1.439		
	MDRO	65	15.18	8.60	1.067	2.69	0.00

TABLE 7: MDROs & Amputations:

	NO AMPUTATION	AMPUTATION	TOTAL	X^2	P VALUE
NON-MDRO	18	2	20		
MDRO	43	37	80	8.84	0.00

Table 8: Healed vs. Non-Healed group.

VARIABLE	HEALED	NON-HEALED	TOTAL	X^2	P VALUE
Age (years)					
<40	2	1	3		
41-50	6	5	11	1.96	0.74
51-60	22	18	40		
61-70	22	18	40		
>70	5	1	6		
Sex					
Male	33	44	77	0.18	0.67
Female	11	12	23		
Socio eco-status					
Class 1	15	16	31		
Class 2	18	27	45		
Class 3	10	12	22	0.58	0.90
Class 4	1	1	2		
Class 5	0	0	0		
Depth of ulcer					
Superficial	23	28	51	0.05	0.82
Deep	21	28	49		
Nature of the ulcer					
Necrotic	34	19	53	18.58	0.00
Non necrotic	10	37	47		
Recurrence					
Recurrent	31	24	55	7.58	0.00
Non recurrent	13	32	45		
Grade of ulcer					
Grade 1	11	0	11		
Grade 2	18	11	29	30.85	0.00
Grade 3	11	18	29		
Grade 4	4	22	26		
Grade 5	0	5	5		
Size of ulcer (cm^2)					
<4 cm^2	5	2	7		
4-8 cm^2	17	16	33	4.90	0.29
8-16cm^2	15	23	38		
16-24 cm^2	6	11	17		
>24 cm^2	1	4	5		
Glycaemic control (hba1c)					
6-7%	14	7	21		
7-8%	24	13	37	25.96	0.00
>8%	6	36	42		
Bacteriology overview					
Mono microbial	25	19	44		
Poly microbial	19	37	56	5.23	0.22
Site of ulcer					
Plantar	2	5	7		
Margins	11	4	15		
Heels	9	18	27	8.99	0.17
Digits	12	14	26		
Malleoli	6	9	15		
Leg	4	4	8		
Multiple areas	0	2	2		
Smoking					
Smoker	21	30	51	0.33	0.56
Non-Smoker	23	26	49		
Alcohol					
Alcoholic	18	28	46	0.81	0.36
Non-Alcoholic	26	28	54		

Previous hospitalization					
Not Hospitalized	25	24	49		
Hospitalized	19	32	51	1.92	0.17
History of amputation					
Present	10	11	21	0.14	0.7.69
Absent	34	45	79		
Prev antibiotic usage					
Absent	30	28	58	3.34	0.06
Present	14	28	42		
Duration of diabetes					
(years mean)	1.86	2.02			
(SD)	0.98	1.09	T=0.76		p=0.44
Duration of ulcer					
(months mean)	1.27	1.5	T=1.38		p=0.17
(SD)	0.74	0.89			
Size of the ulcer					
(Cm^2 mean)	2.57	0.95			
(SD)	2.98	0.96	T=2.13		p=0.03

TABLE 9: Logistic regression: Healed versus non-Healed group.

							95% C.I.for EXP(B)	
		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Step 1[a]	age	.050	.038	1.732	1	.188	1.051	.976	1.132
	size	-.244	.417	.344	1	.558	.783	.346	1.772
	depth	1.141	.802	2.026	1	.155	3.131	.650	15.073
	nature	-.626	.904	.479	1	.489	.535	.091	3.145
	recurrence	.277	.724	.147	1	.702	1.320	.319	5.458
	site			6.389	6	.381			
	site(1)	-3.490	2.511	1.932	1	.165	.031	.000	4.182
	site(2)	-3.334	2.266	2.163	1	.141	.036	.000	3.030
	site(3)	-2.408	2.082	1.338	1	.247	.090	.002	5.324
	site(4)	-2.361	2.020	1.365	1	.243	.094	.002	4.948
	site(5)	-.744	2.072	.129	1	.720	.475	.008	27.591
	site(6)	-2.274	2.411	.889	1	.346	.103	.001	11.615
	culture	-.749	.641	1.367	1	.242	.473	.135	1.660
	hba1c	-1.829	.590	9.596	1	.002	.161	.050	.511
	grade	-1.628	.594	7.514	1	.006	.196	.061	.629
	mdro	.336	.837	.161	1	.688	1.399	.271	7.213
	Constant	8.286	3.681	5.067	1	.024	3968.888		

DISCUSSION

In our study, most of the patients with ulcer had diabetes of less than 5 years duration. This observation was in contrast with other studies conducted in the country which showed more ulcers occurring in patients having diabetes for longer duration [19]. Most of the patients (71%) had ulcers of less than 1 month duration which is similar to the observations from a north Indian study. But according to another north Indian study most ulcers presented to hospital after 3 months [20]. Comparable with the literature most of the patients in the present study had poor glycemic control. Majority of the patients in our study had higher grade of ulcers (Wagner's grade II or worse) similar to the other north Indian studies. In our study, 56 % of ulcers had polymicrobial culture. Similar observations were found in other Indian studies.

13.3 % of isolated *staphylococcus aureus* were Methicillin resistant and coagulase negative (MRCONS), the reports of which in relation to diabetic ulcers were not looked at in the previous studies [21]. In our study we also identified other multi drug resistant gram positive organisms such as MDR *Enterococcus* species, in relation to diabetic foot ulcers (using the guidelines proposed by European center for disease prevention and control). These were not observed in previous studies [22]. With regard to the gram negative organisms in our study, *E.coli* showed greater antibiotic resistance, followed by *Pseudomonas aeruginosa*. 85.71 % of isolated E.coli and 85% of isolated Pseudomonas were multi-drug resistant. In the last two decades; we have seen the emergence of extended spectrum beta lactamase (ESBL) producing gram negative organisms, which have often posed therapeutic challenges. All multi drug resistant E.coli, in our study, was ESBL producers and 15.3% produced both ESBL and AmpC. 3.3 % of isolated *Klebsiella pneumoniae* were ESBL producers. 2% of Proteus mirabilis were ESBL producers. 39 out of the 92 gram negative isolates were ESBL producers, which were isolated from the ulcers in our study. Among the isolated multi-drug resistant organisms, 28% % were MDR E.coli, followed by 18% % MDR *Pseudomonas aeruginosa*, 7.3 % methicillin resistant *Staphylococcus aureus*.

Thus MDROs appear to be firmly entrenched in our patients, and posing questions to clinicians and microbiologists alike, with regard to patient management and the development of antibiotic policies.

In our study, univariate analysis showed that, poor glycemic control, previous hospitalization, previous history of amputation, previous antibiotic usage, size of ulcer, necrotic ulcer, recurrent ulcers, higher grade of ulcer, presence of osteomyelitis, presence of polymicrobial culture, were significantly associated with MDRO infected foot ulcers [23]. However, analysis by logistic regression revealed that only the recurrent ulcers and higher grade of ulcers were significantly associated with multi-drug resistant organism infections. It is possible that patients with recurrent ulcers have had several courses of antibiotics, both during previous hospital admissions and from practitioners in the community, which led to resistance to multiple antibiotics. Higher grade of ulcers have an associated systemic sepsis and excessive local necrotic tissues [24].

In our study, the presence of MDRO in foot ulcers significantly increased the duration of hospital stay and the associated cost. The mean duration of hospital stay in MDRO infected ulcer group was 15.18 days and that of non-MDRO group was 10.34 days. Patients with MDRO had an increased the rate of amputations both major and minor, in our study. We have seen that MDRO infections are associated with higher grade ulcers, and this could offer an explanation for the increased amputations. We found significant by univariate analysis, the presence of MDRO had no role in determining the wound healing. This could be because of prompt change of antibiotics as dictated by the culture and sensitivity reports. Similarly other factors like smoking, size and depth of ulcers, duration of diabetes had no role in influencing the duration of wound healing [25].

CONCLUSION

The prevalence of MDRO is alarmingly high, which shows the urgent need for implementation of strict antibiotic policy and infection control measures to avoid antibiotic resistance. Recurrent ulcers, higher grade of ulcers is more prone to acquire multi-drug resistant organisms. *Escherichia coli* are commonest isolate, ESBL *Escherichia coli* are the commonest multi-drug resistant organism derived from infected diabetic foot ulcer. Multi-drug resistant organisms in diabetic foot ulcers are associated with longer duration of hospital stay. Rate of amputations are significantly higher with multi-drug resistant organism infected diabetic foot ulcers. Multi-drug resistant organisms have no significant impact on wound healing, while Inter-digital / digital ulcers, higher grade of ulcer and poor glycemic control delay the healing of foot ulcer.

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Conflicts Of Interest

No conflicts of interest have been declared.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethics Approval

All procedures performed in studies involving human participants were in accordance with the ethical Standards of the Institutional Ethics Committee and with the 1964 Helsinki declaration and its later amendments or Comparable ethical standards.

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