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Original Research Article

Risk factors for the diabetic foot infection with multidrug-resistant microorganisms in South India

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ABSTRACT

Background: To analyse the risk-factors contributing to infection with multidrug-resistant organisms.
Methods: A 150 diabetic patients with foot ulcer were prospectively studied. Detailed clinical history and clinical examination of the ulcer were done for all patients. The microbiological profile was analyzed for each patient. Using internationally accepted criteria, the multidrug-resistant organisms were identified. Risk factors for acquiring MDRO infection were identified using appropriate statistical tools.
Results: MDRO were isolated from 99 patients of 150 (66%). A 54.8% (153 out of 279) of isolated organisms were multidrug-resistant organisms. By univariate analysis poor glycaemic control, previous hospitalisation, previous history of amputation, previous antibiotic usage, size of the ulcer, necrotic ulcer, recurrent ulcers, higher grade of ulcer, the presence of osteomyelitis, the presence of retinopathy, peripheral vascular disease, neuropathy and polymicrobial culture, were significantly associated with MDRO infected foot ulcers. Analysis by logistic regression indicated that only two factors significantly increased the risk of acquiring MDRO infection. They are recurrent ulcer (OR = 3.39, p <0.05, 95% CI = 1.081-10.664) and higher grade of ulcer (OR = 13.44, p <0.001, 95 % CI =3.595-50.278).
Conclusions: The prevalence of MDRO is alarmingly high in infected diabetic foot ulcers. Recurrent ulcers and higher grade of ulcers are more prone to acquire MDROs.

Keywords: Diabetic foot, MDRO, Polymicrobial infection, Risk factors

INTRODUCTION

India has the second largest number of patients living with diabetes world wide, with as many as 82 million adults suffering from this disease and its complications.[1] Development of foot ulcers is seen in 15% of all diabetic patients during their lifetime.[2] This is associated with a significant economic burden. The health expenditure is 5 times more in diabetics with foot ulcers than in those without foot ulcers.[1]

Infection of foot ulcers is often due to more than one organism and it is, therefore, imperative that appropriate antibiotic therapy is instituted.[3] Infection with multidrug resistance organisms will increase the morbidity and consequently, the finances involved, to a significant extent.[4] Emergence of multi-drug resistance organisms (MDRO) is the area of major concern in both developing and developed countries.[5] In India, a lack of adherence to protocol in prescribing antibiotics leads to the emergence of these super bugs.[6] Also patient related factors also play

an important role in the development of such organisms. Diabetes is one such factor and its complication such as foot ulcer harbors MDRO.

There are various other factors involved in the emergence of MDRO in diabetic foot ulers. Very few studies have been done in India, to elucidate the underlying risk factors for the development MDRO in diabetic foot ulcer. Present study aims to correlate the risk factors and their association with the development of MDRO in diabetic foot ulcers in South India.

METHODS

One hundred fifty diabetic patients with foot lesions were included in the study, conducted between January 2011 and July 2012, at PSG Institute of Medical Sciences and Research, Coimbatore, India, after obtaining approval from the institutional review board. Clinical history was collected using structured case report forms. Mode of presentation of foot ulcers were classified as grade I to V as per Meggit Wagner Classification System (Wagner, 1981). Ulcers were categorised into necrotic/non-necrotic ulcers based on signs of infection (swelling, exudates, surrounding cellulitis, odour, tissue necrosis and crepitation). Size was determined by multiplying the longest and widest diameters expressed in centimeters squared (cm^2), and the diagnosis of extension to the bone was made by plain radiographs. Presence of neuropathy was detected by assessing vibration sensation using a 128 HTZ tuning fork and a 10gm Semmes - Weinstein monofilament. Peripheral diabetic neuropathy was defined as an abnormal monofilament test, as described by the international consensus on the diabetic foot.[7] Presence of nephropathy was detected by screening the patient's urine for micro / macro-albuminuria after ruling out urinary tract infection. The fundus was examined by the ophthalmologist for evidence of retinopathy. Absence of both dorsalis-pedis pulsations and/or an Ankle Brachial Index (ABI) less than 0.9 was termed as peripheral vascular disease.

Wound swabs were obtained from the floor of the ulcer, before starting empirical antibiotic therapy. Direct microscopic examination and aerobic cultures were done by standard methods. The bacteriological spectrum and the sensitive antibiotics were noted for each patient. All patients were started on empirical antibiotics depending on the status of the wound. In mild infection amoxyclav (amoxicillin/clavulanic acid) was given by oral route. But in patients with necrotic wounds, an additional antibiotic, clindamycin or metronidazole, was added for anaerobic and gram-negative coverage and the intravenous route was preferred. In the presence of an unhealthy ulcer, surgical debridement / amputation was done immediately after admission. Later wounds were managed with regular dressings and antibiotics modified according to the culture report. All patients were re-inspected or enquired over phone after a period of 10 weeks to assess the status of wound. For each patient, the following details were entered: age, sex, duration of ulcer, duration of diabetes, glycaemic control, presence of retinopathy, presence of micro/macro-albuminuria, hypertension, history of smoking, history of previous amputation, duration of hospital stay, interventions (medical and surgical), organisms cultured from ulcer, antibiotic profile and status of ulcer after 10 weeks. Previous hospitalization was defined as any hospital stay, which was not necessarily for the management of ulcer, during the year preceding the current hospitalization. Previous antibiotic usage was defined in present study, as those who had received antibiotics in six months preceding current hospitalization.

The data was collected and entered in the SPSS data sheet. The data was analysed using SPSS 20 for descriptive statistics. To assess the risk factors for acquiring MDRO, the patients were grouped into MDRO and non-MDRO groups. All patients, who had at least one multidrug resistant organism, were grouped under MDRO group. The test variables were compared using Chi-square test for qualitative variables and Student's test for quantitative variables. The variables for which the association was statistically significant ($p<0.1$) were introduced in a logistic model. Univariate analysis was performed to compare infected ulcers according to the presence or absence of MDRO. Logistic regression was used to identify explanatory variables for the presence of MDRO.

RESULTS

Seventy-eight percentage of the patients were 51 years or older. A 74.6% of the patients were males, showing a distinct male preponderance. Most of the patients (44%) belonged to class II socio-economic status followed by class III (26 %), as per Modified Prasad's classification (Table 1).[8]

Table 1: Demographic details.

Variable	Number	Percentage
Age distribution		
<40	5	3.3%
41-50	16	10.7%
51-60	55	36.7%
61-70	62	41.3%
71-80	10	6.7%
81-90	2	1.3%
Sex distribution		
Male	112	74.6%
Female	38	25.33%
Socio-economic status		
Class I	39	26%
Class II	66	44%
Class III	39	26%
Class IV	6	4%
Class V	0	0%

Table 2: Diabetes profile.

Variable	Number	Percentage
Duration of diabetes		
<5 yrs	60	40 %
5-10 yrs	51	34 %
10-15 yrs	26	17 %
15-20 yrs	11	7.3 %
>20 yrs	2	1.3 %
Glycaemic control		
6-7% (good)	29	19.33%
7-8% (fair)	54	36 %
>8 % (poor)	67	44.66 %

Table 3: Foot ulcer profile.

Variable	Number	Percentage
Duration of ulcer		
<1 month	102	68%
1-2 months	34	22.7%
2-3 months	9	6 %
>3 months	5	3.3%
Size of the ulcer		
<4 cm^2	11	7.3%
4-8 cm^2	49	32.7%
8-16 cm^2	61	40.7%
16-24 cm^2	23	15.3%
>24 cm^2	6	4%
Depth of ulcer		
Superficial	92	61.33%
Deep	58	38.66%
Grade of ulcer		
Grade I	17	11.33%
Grade II	40	26.66%
Grade III	45	30%
Grade IV	35	23.33%
Grade V	13	8.66%
Nature of ulcer		
Non-necrotic	78	52%
Necrotic	72	48%
Recurrence		
Non-recurrent	79	52.66%
Recurrent	71	47.33%
Osteomyelitis		
Absent	99	66%
Present	51	34%
Site of ulcer		
Plantar	16	10.66%
Margins	24	16%
Heel	42	28%
Digits	32	21.33%
Malleoli	18	12%
Leg	16	10.66%
Multiple areas	2	1.33%

Almost all the patients had type II diabetes, with only 4% of them having type I. Only 19.33% of patients had a good glycemic control, with HbA1c 6-7%. 40% of patients with ulcer, had diabetes for less than five years (Table 2).

Table 4: Bacteriology overview.

	No. of patients	Percentage
Culture		
Mono-microbial	62	41.33%
Poly-microbial	88	58.66%
Drug resistance		
MDRO	99	66%
Non- MDRO	51	34%

Table 5: Other associated history.

Variable	Number	Percentage
Arteriopathy		
Absent	79	52.66%
Present	71	47.33%
Retinopathy		
Absent	113	75.33%
Present	37	24.66%
Nephropathy		
Absent	77	51.33%
Present	73	48.66%
Neuropathy		
Absent	34	22.66%
Present	116	77.33%
Hypertension		
Absent	58	38.66%
Present	92	61.33%
Smoking		
Non-smoker	75	50%
Smoker	75	50%
Alcohol		
Non-alcoholic	88	58.66%
Alcoholic	62	41.33%
Previous hospitalization		
Not hospitalized	70	46.66%
Hospitalized	80	53.33%
H/o amputation		
Absent	118	78.6%
Present	32	21.33%
Previous antibiotic use		
Absent	86	57.33%
Present	64	42.66%

Sixty-eight percentage of patients had ulcers of less than one-month duration. Concerning the size of the ulcer, most were between 4 to 8cm^2 and 8 to 16cm^2. Most of the patients had Wagner's grade II, III, or IV ulcers. There were very few ulcers with Wagner's grade V. There was an almost equal distribution of necrotic and non-necrotic ulcers and also recurrent and non-recurrent ulcers.

Table 6: MDRO versus non-MDRO (univariate analysis).

Variable	Non MDRO	MDRO	Total	X^2	P value
Age					
<40	3 (60%)	2 (40%)	5 (100%)	6.373	0.272
41 - 50	8 (50%)	8 (50%)	16 (100%)		
51 - 60	14 (25.5%)	41 (74.5%)	55 (100%)		
61 - 70	22 (35.5%)	40 (64.5%)	62 (100%)		
71 - 80	4 (40%)	6 (60%)	10 (100%)		
81 - 90	0 (0%)	2 (100%)	2 (100%)		
Sex					
Male	35 (31.2%)	77 (68.8%)	112 (100%)	1.490	0.222
Female	16 (42.1%)	22 (57.9%)	38 (100%)		
Socio eco- status					
Class I	14 (35.9%)	25 (64.1%)	39 (100%)	0.266	0.966
Class II	23 (34.8%)	43 (65.2%)	66 (100%)		
Class III	12 (30.8%)	27 (69.2%)	39 (100%)		
Class IV	2 (33.3%)	4 (66.7%)	6 (100%)		
Class V	0 (0%)	0 (0%)	0 (0%)		
Type of diabetes					
I	3 (50%)	3 (50%)	6 (100%)	0.713	0.398
II	48 (33.3%)	96 (66.7%)	144 (100%)		
Depth of ulcer					
Superficial	26 (28.3%)	66 (71.7%)	92 (100%)	3.492	0.062
Deep	25 (43.1%)	33 (56.9%)	58 (100%)		
Nature of ulcer					
Non-necrotic	42 (53.8%)	36 (46.2%)	78 (100%)	28.52	0.000
Necrotic	9 (12.5%)	63 (87.5%)	72 (100%)		
Recurrence					
Non-recurrent	42 (53.2%)	37 (46.8%)	79 (100%)	27.31	0.000
Recurrent	9 (12.7%)	62 (87.3%)	71 (100%)		
Grade of ulcer					
Class I	15 (88.2%)	2 (11.8%)	17 (100%)	62.83	0.000
Class II	26 (65%)	14 (35%)	40 (100%)		
Class III	3 (6.7%)	42 (93.3%)	45(100%)		
Class IV	6 (17.1%)	29 (82.9%)	35 (100%)		
Class V	1 (7.7%)	12 (92.3%)	13 (100%)		
Retinopathy					
Absent	44 (38.9%)	69 (61.1%)	113 (100%)	4.978	0.026
Present	7 (18.9%)	30 (81.1%)	37 (100%)		
Nephropathy					
Absent	29 (37.7%)	48 (62.3%)	77 (100%)	0.946	0.331
Present	22 (30.1%)	51 (69.9%)	73 (100%)		
Osteomyelitis					
Absent	43 (43.4%)	56 (56.6%)	99 (100%)	11.549	0.001
Present	8 (15.7%)	43 (84.3%)	51 (100%)		
Arteriopathy					
Absent	38 (48.1%)	41 (51.9%)	79 (100%)	14.789	0.000
Present	13 (18.3%)	58 (81.7%)	71 (100%)		
Neuropathy					
Absent	20 (58.8%)	14 (41.2%)	34 (100%)	12.0	0.001
Present	31 (26.7%)	85 (73.3%)	116 (100%)		
Hypertension					

Table 6: MDRO versus non-MDRO (univariate analysis).

Variable	Non MDRO	MDRO	Total	X^2	P value
Absent	19 (32.8%)	39 (67.2%)	58 (100%)	0.065	0.799
Present	32 (34.8%)	60 (65.2%)	92 (100%)		
Glycaemic control (HBA1C)					
6-7 %(good)	17 (58.6%)	12 (41.4%)	29 (100%)	18.84	0.000
7-8 % (fair)	23 (42.6%)	31 (57.4%)	54 (100%)		
>8 % (poor)	11 (16.4%)	56 (83.6%)	67 (100%)		
Previous admission					
Not hospitalized	32 (45.7%)	38 (54.3%)	70 (100%)	8.026	0.005
Hospitalized	19 (23.8%)	61 (76.2%)	80 (100%)		
Smoking					
Non-smoker	30 (40%)	45 (60%)	75 (100%)	2.406	0.121
Smoker	21 (28%)	54 (72%)	75 (100%)		
Alcoholic					
Non- alcoholic	33 (37.5%)	55 (62.5%)	88 (100%)	1.162	0.281
Alcoholic	18 (29%)	44 (71%)	62 (100%)		
History of amputation					
Absent	45 (38.1%)	73 (61.9%)	118 (100%)	4.216	0.040
Present	6 (18.8%)	26 (81.2%)	32 (100%)		
Culture					
Mono microbial	31 (50%)	31 (50%)	62 (100%)	12.05	0.001
Poly microbial	20 (22.7%)	68 (77.3%)	88 (100%)		
Site					
Plantar	10 (62.5%)	6 (37.5%)	16 (100%)	7.831	0.251
Margins	8 (33.3%)	16 (66.7%)	24 (100%)		
Heel	14 (33.3%)	28 (66.7%)	42 (100%)		
Inter digital	10 (31.2%)	22 (68.8%)	32 (100%)		
Malleoli	5 (27.8%)	13 (72.2%)	18 (100%)		
Leg	4 (25%)	12 (75%)	16 (100%)		
Multiple areas	0 (0%)	2 (100%)	2 (100%)		
Duration of diabetes (years) mean (SD)	1.84 (0.94)	2.02 (1.02)		T= 1.032	0.30
Duration of ulcer (months mean) (SD)	1.49 (0.73)	1.42 (0.77)		T = 0.50	0.61
Size of the ulcer cm^2 mean (SD)	2.47 (0.80)	2.91 (0.97)		T = 2.76	0.006

Table 7: Logistic regression MDRO Vs non- MDRO.

	B	SE	Wald	DF	Sig.	Exp(b)	95% c.i. for exp(b)	
							Lower	Upper
Nature	0.172	0.730	0.056	1	0.814	1.188	0.284	4.970
Recurrence	1.222	0.584	4.382	1	0.036	3.395	1.081	10.664
Grade	2.599	0.673	14.910	1	0.000	13.445	3.595	50.278
Retinopathy	0.221	0.631	0.123	1	0.726	1.247	0.362	4.292
Osteomyelitis	-0.260	0.672	0.150	1	0.699	0.771	0.206	2.880
PVD	0.540	0.537	1.013	1	0.314	1.716	0.600	4.911
Neuropathy	-0.275	0.675	0.166	1	0.684	0.760	0.202	2.854
HBA1C	1.105	0.631	3.062	1	0.080	3.019	0.876	10.403
Prev-hospital	0.161	0.608	0.070	1	0.791	1.175	0.357	3.870
H/o amputation	0.630	0.769	0.672	1	0.412	1.878	0.416	8.481
Pre-antibiotic	0.267	0.636	0.176	1	0.675	1.305	0.376	4.537
Culture	0.889	0.523	2.884	1	0.089	2.432	0.872	6.783
Size	0.293	0.285	1.053	1	0.305	1.340	0.766	2.345
Age	-0.005	0.029	0.029	1	0.865	0.995	0.939	1.054
Constant	-3.418	2.054	2.767	1	0.096	0.033		

Thirty-four percentage of ulcers had associated osteomyelitis. 28% of ulcers were seen in the heel, followed by 21.33% in digits/inter-digital areas (Table 3).

A total of 279 organisms were isolated from 150 patients. On an average 1.86 species were isolated from each patient. 58.66% of patients (88 of the 150 patients) had polymicrobial culture. Among the isolates, most were gram-negative rods (69.89%), and almost all the rest were gram-positive cocci. There was a solitary gram-negative coccus. Gram-positive to gram-negative ratio, among the isolates, was 1:2.3. Among the isolates, *Escherichia coli* was the most common one constituting 17.9%. MDROs were seen in 99 of the 150 patients (Tables 4).

Peripheral arterial disease was seen in 52.66%, retinopathy detected in 24.66% and albuminuria suggesting nephropathy was found in 48.66%. Majority of the patients had neuropathy. 61.33% were hypertensive.

Fifty percentage of the patients were smokers and 41.33% alcoholics. History of previous hospital admission in the last one year was seen in 53.33%. 21.33 % of patients had history of some form of amputation. 42.66% of the patients had a history of antibiotic use in the preceding six months before admission (Table 5).

Results of the univariate analysis showed 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 retinopathy, peripheral vascular disease, neuropathy and polymicrobial culture, were significantly associated with MDRO infected foot ulcers (Table: 6). However logistic regression results indicated that only two factors significantly increased the chances of acquiring MDRO infection; recurrent ulcer (OR=3.39, p <0.05, 95% CI=1.081-10.664), higher grade of ulcer (OR=13.44, p <0.001, 95% CI=3.595-50.278) (Table 7).

DISCUSSION

Infection with MDRO in diabetic foot ulcers associated with inadequate glycemic control and increased requirement of surgical management.[9] In this study presents a comprehensive clinical and microbiological profile of infected diabetic foot ulcers, especially about multidrug-resistant organisms. With a large number of patients being admitted with diabetic foot ulcers and with the growing global problem of multidrug-resistant organisms, this was a study to ascertain the role of multidrug-resistant organisms in relation to diabetic foot ulcers.

In the present study, the foot ulcers were more prevalent in the fifth and sixth decade of life. The average age of the patients with foot ulcer was 58.21±9.3 years, which is similar to the age prevalence described in another Indian study.[10] The foot ulcers were more common in male. Similar gender preponderance was observed in another study conducted in India.[11]

Most of the patients (68%) had ulcers of less than 1-month duration which is similar to the observations from a north Indian study.[11] An early presentation is often due to the fact that ulcers with acute onset often have systemic symptoms. Comparable with the literature, most of the patients in the present study had poor glycaemic control.[11] Poor glycaemic control is associated with higher degree of microvascular complications.

Majority of the patients in present study had a higher grade of ulcers (Wagner's grade III or worse) similar to the other north Indian studies.[11,12] The reason for presentation with higher grade could be because of lack of structured health care delivery in the country, attempted self-medication and trust in traditional healers.[12]

In the present study, the neuropathy was seen in 77.33% of the diabetic foot ulcer patients. The other studies reported from India showed a similar high prevalence (86.2%, 66.6%, and 56.8% respectively).[9,11] A prevalence ranging from 32 to 33.5% have been reported in studies done in Europe.[13,14] Studies elsewhere have a shown a varied prevalence ranging from 12.7% to 77.8%. This marked variation in the prevalence may be due to different methods used for diagnosing neuropathy. A higher prevalence in Indian population, could be because of patient's ignorance and poor glycaemic control.

In the present study, the prevalence of retinopathy was 24.66%. Studies conducted in northern India showed a higher prevalence.[9,12]

Peripheral arterial disease was observed in 47.33% of present study group. A very high prevalence of 85% was seen in a north Indian study.[9] The prevalence of nephropathy was 48.66% in present study. The north Indian study showed a high prevalence (75%).[11]

The bacteriological evaluation of diabetic foot ulcer from present study showed that the gram-negative organisms were found to have a higher occurrence than gram-positive organisms in the ratio 2.3: 1. Some of the other Indian studies also showed a higher occurrence of gram-negative organisms.[9,12] However, most of the western literature showed a predominance of gram-positive organisms as supposed to gram-negative organisms.[15-17] This could be partly due to differences in the causative organisms occurring over time, geographical variations, or the types and severity of infection included in the studies.[18]

Diabetic foot infection is usually polymicrobial in nature which is well documented in the literature. In present study, 58.66% of ulcers had polymicrobial culture. Similar observations were found in other Indian studies and western studies.[9,12,18] There are, however, a few studies which showed more patients with monomicrobial culture.[19,20] Polymicrobial infection, to a certain extent, may be due to prior treatment history of the patients studied, as reported earlier.[21,22]

In the present study, the rate of isolation of organism per ulcer was 1.86 while two other Indian studies showed a rate of 1.25 and 2.3 organisms per ulcer.[9,11] A study from Malaysian reported 1.47 organisms per lesion.[20] A study from US showed a very high rate of 5.8 organisms recovered from the ulcer.[23]

The commonest organism isolated in present study was *Escherichia coli* followed by *Staphylococcus aureus*, *Pseudomonas* and *Klebsiella pneumoniae*. Most of the other studies from India and other countries showed Staphylococcus aureus as the commonest isolate from diabetic foot ulcers.[9,11,16,18,20]

In the present study, 66% of the ulcers grew multi-drug resistant organisms (MDRO) and 54.8% of all isolated organisms were multidrug resistant. Many different definitions for multi-drug resistant organisms were used in medical literature. Due to a lack of uniform definition for MDROs, the overall prevalence of MDRO, as seen in the literature, could not be studied. European centre for disease prevention and control has arrived at a definition for MDROs and has defined specific criteria for categorising an organism as MDRO.[24]

Apart from the multi-drug resistant organisms like MRSA, ESBL and VRE which were extensively studied in the literature, other groups of organisms like MDR *Pseudomonas*, *Acinetobacter*, *Enterococcus* and *Enterobactereciae* were also identified in present study. The higher prevalence of multidrug-resistant organisms was also observed in another north Indian study.[9] The higher antibiotic resistance in tertiary care hospitals is because, widespread use of broad-spectrum antibiotics results in selective survival of drug-resistant organisms. In contrast, a western study showed a lower prevalence of MDRO when compared to Indian literature, which is perhaps a reflection of higher antibiotic use and abuse.[16] The increasing occurrence of MDROs is disconcerting because infection with these organisms limits the choice of antibiotic treatment and may lead to a worse outcome.

In the present study, univariate analysis showed that, poor glycaemic control, previous hospitalisation, previous history of amputation, previous antibiotic usage, size of the ulcer, necrotic ulcer, recurrent ulcers, higher grade of ulcer, presence of osteomyelitis, presence of retinopathy, peripheral vascular disease, neuropathy and polymicrobial culture, were significantly associated with MDRO infected foot ulcers.

However, analysis by logistic regression revealed that only 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 has an associated systemic sepsis and excessive local necrotic tissues.

Another study from India showed that presence of neuropathy and ulcer size >4cm^2 were significantly associated with multi-drug resistant organism infections.[9] The two significant factors associated with MDRO, in a study from France, were previous hospitalization and proliferative retinopathy.[16]

Factors like previous hospitalization, previous antibiotic usage, poor glycaemic control, ischemic ulcers have emerged as possible risk factors for MDRO in several other studies.[4,9,16] However, we have not found any significant association in present study.

Although author have identified a few factors associated with MDRO, the effect of diabetes-related immunopathology has not been studied. This and its possible impact on infection need a closer look.

CONCLUSION

The prevalence of multi-drug resistant organisms is alarmingly high in infected diabetic foot ulcers. Recurrent ulcers are more prone to acquire multi-drug resistant organisms. Higher grade of ulcers is more prone to acquire multi-drug resistant organisms.

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