

CLINICO-PATHOLOGICAL EVALUATION AND MANAGEMENT OF NECROTIZING FASCIITIS IN A TERTIARY CARE HOSPITAL

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Abstract

Background: Necrotising fasciitis lesions are entities not frequently seen in daily surgical practice. These infections are marked by absence of clear local boundaries or palpable limits, which is responsible both for their severity and the frequent delay in recognizing their surgical nature. Necrotising fasciitis continues to challenge the practicing surgeon. **Aims:** to study patients presenting with necrotizing fasciitis there Predisposing factors, Comorbid conditions associated, Microbiology, Management and Outcome of patients. **Materials and Methods:** This prospective observational study was done at the Department of General Surgery in Fifty patients with necrotizing fasciitis meeting the criteria of the present study who were admitted to various surgical units were included in this study. **Results:** Case volume was found to be maximum in the age group 51 to 60 years (40%), Males were found to be predominantly affected (80%) signifying Necrotizing fasciitis occurs more commonly in the older age group. Around 80 % of the patients who underwent amputation also presented with septic shock. The most common isolated organism is E.Coli followed by streptococcus and staphylococcus aureus. Appropriate antibiotic administration is the mainstay of treatment. Organisms were mostly sensitive to amoxicillin-clavulanic acid, piperacillin followed by levofloxacin and meropenem. 22% of the patients had an amputation. Patients with diabetes, smokers, hypoalbuminemia, Peripheral vascular disease, and those who presented late had a higher incidence of amputation. The mortality rate was around 12%. Mortality was high in diabetics, patients with anaemia, hypoalbuminemia (albumin levels less than 3), who presented late (more than seven days from the onset of symptoms to presentation to hospital) and had septic shock. Hence, early presentation without comorbidities like diabetes, anaemia, hypoproteinaemia, and PVD were good prognostic factors. **Conclusion:** Necrotising fasciitis is more common in middle aged males. Diabetes mellitus is the most common co-morbid condition associated with necrotising fasciitis. Type I infection is more common. The presence of multiple co-morbid conditions reduces the survival. Early diagnosis and aggressive surgical debridement reduces mortality.

INTRODUCTION

Necrotizing fasciitis (NF) is a type of soft-tissue infection characterized by rapidly progressing inflammation and necrosis involving the skin, subcutaneous tissue, fascia and muscle. NF primarily damages the subcutaneous tissue then the superficial and deep fascial layers. The aetiology can be polymicrobial (mixed aerobic-anaerobic microbes) or monomicrobial (group A Streptococcus, community-acquired MRSA). NF affects all age groups but is more frequently reported in middle-aged and elderly patients (>50 years). The ratio of

male to female is 3:1. The lower limbs are mainly affected, followed by perineum and external genitalia (Fournier's gangrene). It is mainly seen in lower economic status. Any risk factor that leads to disruption of skin or mucosal integrity can result in necrotizing fasciitis. It mainly affects people with diabetes, alcoholics, IV drug abusers, immunosuppressed, patients with peripheral vascular disease.^[1,2]

The initial presentation is similar to cellulitis, advancing rapidly or slowly. The most common mode of spread is direct spread. In severe cases, the microorganisms can spread by haematogenous and

lymphatic route resulting in sepsis and shock. In addition, there is systemic toxicity, often including high temperatures, disorientation, and lethargy as it progresses. Examination of the local site reveals cutaneous inflammation, oedema, discolouration or gangrene and loss of sensation. A distinguishing clinical feature is the wooden-hard induration of the subcutaneous tissues.

NF is rapidly fatal unless quickly diagnosed and aggressively treated as an emergency with repeated surgical interventions and high doses of broad-spectrum antibiotics through parenteral route. Hence, an attempt is made in the present study to determine the microbial flora and the predisposing comorbid conditions and aimed to formulate a protocol for the management of necrotizing fasciitis and find the outcome of the patients. To analyse the presentation of patients, Predisposing factors of necrotizing fasciitis, Comorbid conditions associated, Microbiology, Management, Outcome of patients with necrotizing fasciitis.

MATERIALS AND METHODS

This prospective observational study was done at the Department of General Surgery, NRI IMS, Visakhapatnam, Andhra Pradesh, from September 2019 to August 2021. Fifty patients with necrotizing fasciitis meeting the criteria of the present study who were admitted to various surgical units at NRI IMS were included in this study.

Inclusion Criteria

Age between 18yrs to 80 yrs and presenting with features of necrotizing fasciitis.

Exclusion Criteria

Pregnant women.

The present study was approved by the hospital ethics committee.

Patients presenting with signs and symptoms of necrotizing fasciitis like fever and pain, swelling, tenderness, discolouration of the lower limbs were included in the study. The initial diagnosis was made by clinical history and examination of the limb. The diagnosis was confirmed during surgical exploration. Demographic details like age, sex, occupation,

education, address, marital status, history of present illness, personal history and past history were noted. In addition, vital data, general condition of the patient were noted.

Predisposing factors: History of diabetes, claudication pain, trauma, pedal oedema was also taken. The following investigations were done. Routine investigations like complete blood picture, renal function tests, serum electrolytes, liver function tests, viral markers were done. Fasting blood sugar, PPBS, HbA1c was done.

Culture is obtained using a swab as soon as possible, preferably from the necrotic centre, and the sample was sent to microbiology. Basal media like nutrient agar, blood agar, Mac conkey agar were used to culture bacteria. The cultured organisms were tested for resistance patterns by the disc diffusion method. Colour Doppler of the arterial and venous system of the lower limb was done in all patients to detect Peripheral Vascular disease. X-ray of the affected limb was done. The patient was initiated on supportive management with IV fluids and broad-spectrum empirical antibiotics. Appropriate antibiotics were later changed based on sensitivity. Removal of necrotic tissue and drainage of fascial planes by extensive fasciotomy under anaesthesia was done. Debridement was repeated within 24 hrs depending on the patient condition. Amputation is indicated in certain patients with severe sepsis and where limb salvage is not possible. Regular dressings are advised. Skin grafting/ flap reconstruction was done in those who recovered.

Statistical Analysis

The mean, standard deviation, and frequencies were calculated for descriptive statistical analysis. Different characteristics were represented as numbers or percentages wherever required. Comparisons between groups were performed using the student t-test or the Mann-Whitney U test for Continuous variables and the chi-square test (χ^2) or the Fisher exact test for categorical data. p-Value shows the significance level ($p < 0.05$). Tables and charts were completed using Microsoft word and excel software. Statistical analysis was done by statistical software SPSS for Windows v17.0 (SPSS, Chicago, IL, USA).

RESULTS

Table 1: Distribution of study participants based on Gender

Gender	Number of cases	Percentage
Male	40	80.0
Female	10	20.
Total	50	100
Age		
18 – 30	3	6.0
31 – 40	3	6.0
41 – 50	9	18.0
51 – 60	20	40.0
61 – 70	8	16.0
71 – 80	7	14.0
Site		

Lower Limbs	45	90%
Perineum And External Genitalia	05	10%
Diabetes		
Diabetic	29	58.0
Non – diabetic	21	42.0
Hypertensive		
Hypertensive	23	46.0
Non-hypertensive	27	54.0
Peripheral Vascular Disease		
PVD Present	7	14.0
PVD Absent	43	86.0
Smokers		
Smokers	39	78.0
Non-Smokers	11	22.0

In the present study, the majority of the patients were males. Males constituted 80% of the study population, the remaining 20 % were females. The majority of the study participants (n=20) were in the older age group (51 to 60 years) followed by 41 to 50 years constituting 9 patients. 7 patients were above 70 yrs of age. Only three patients were younger than 30 yrs of age. The mean age of the study population is 56.38±10.59 years. In this study, the most common comorbidity detected is diabetes. Around 58% of the study population had diabetes. 46% of the study subjects were hypertensive at the time of admission. The majority (78%) of the patients are smokers.

Table 2: PVD vs various factors

		PVD			
		Absent		Present	
		Count	%	Count	%
SEX	Female	8	18.6%	2	28.6%
	Male	35	81.4%	5	71.4%
Diabetes		23	79.3%	6	20.7%
Smoking		32	82.1%	7	17.9%
Amputation		6	45.5%	6	54.5%

Of the 7 cases of PVD, 5 were males, and 2 were females. The majority of them were diabetic (n=6) and smokers (n = 7). 6 of them underwent amputation.

Table 3: Clinical features and duration of symptoms of Study participants

Clinical features	Frequency	Percent
Pain	49	98.0
Swelling	42	84.0
Blackish Discolouration	37	74.0
Fever	35	70.0
Total	50	100.0
Duration of onset of symptoms		
< 7 days	35	70
> 7 days	15	30

Pain was the most common presenting symptom.98% of the patients had pain in the lower limb. The majority (70%) of the patients presented with fever. 74% of the total study participants had blackish discoloration of the limb. The majority (70%) of the patients presented within seven days after onset of symptoms 15 patients presented late.

Table 4: Incidence of anaemia and hypoalbuminemia

Hb (g/dl)	Frequency	Percent
< 10	19	38.0
> 10	31	62.0
Albumin (g/dl)		
<3	12	24.0
>3	38	76.0

The mean Hb values are 10.78 ± 2.34 g/dl and mean Albumin levels ranging from 3.32 ± 0.67g/dl. 38% of cases had anaemia (<10g/dl). 24% of cases had albumin <3 g/dl.

Table 5: Distribution of Study participants based on presence or absence of complications

Sepsis	Frequency	Percent
YES	35	70.0
NO	15	30.0
Total	50	100.0
Shock		
YES	16	32.0
NO	34	68.0
Acute Kidney Injury		
Yes	9	18.0
No	41	82.0

The majority (70%) of the patients presented with sepsis. Sixteen cases presented with septic shock. 18 % of the patients had Acute Kidney Injury.

Table 6: Presence of Different organisms in Culture

Organisms	Frequency	Percent
E. Coli	19	38.0
Klebsiella	2	4.0
Proteus	1	2.0
Pseudomonas aeruginosa	5	10.0
Staphylococcus aureus	12	24.0
Streptococcus	11	22.0
Total	50	100.0

E. Coli is the most common organism found in the culture, followed by Streptococcus and Staphylococcus aureus. Proteus is the least common organism observed in culture.

Table 7: Culture Vs Age distribution

Organisms	41-50		51-60		61-70		71-80		71 - 80	
	Count	Row N%	Count	Row N%	Count	Row N%	Count	Row N%	Count	Row N%
E Coli	2	8.30 %	4	16.70 %	10	41.70%	5	20.80 %	3	12.50%
Klebsiella	0	0.00 %	0	0.00 %	2	50.00%	2	50.00 %	0	0.00%
Proteus	0	0.00 %	0	0.00 %	1	100.00 %	0	0.00 %	0	0.00%
Pseudomonas aeruginosa	0	0.00 %	0	0.00 %	2	66.70%	1	33.30 %	0	0.00%
Staph aureus	0	0.00 %	0	0.00 %	4	57.10%	1	14.30 %	2	28.60%
Streptococcus	1	9.10 %	7	63.60 %	2	18.20%	0	0.00 %	1	9.10%

E Coli is seen in all age groups but commonly after 60 years. Streptococcus was also observed in all age groups but predominantly above 50 years.

Table 8: Culture Vs Diabetes status and Vs Amputation in present study

Culture Vs Diabetes status	Diabetes			
	No		Yes	
	Count	%	Count	%
E. Coli	7	36.8%	12	63.2%
Klebsiella	0	0.0%	2	100.0%
Proteus	0	0.0%	1	100.0%
Pseudomonas aeruginosa	2	40.0%	3	60.0%
Staphylococcus aureus	3	25.0%	9	75.0%
Streptococcus	9	81.8%	2	18.2%
Total	19	38.0%	31	62.0%
P-value = 0.05*				
Culture Vs Amputation				
E. Coli	15	78.9%	4	21.1%
Klebsiella	1	50.0%	1	50.0%
Proteus	1	100.0%	0	0.0%
Pseudomonas aeruginosa	5	100.0%	0	0.0%

Staphylococcus aureus	6	50.0%	6	50.0%
Streptococcus	11	100.0%	0	0.0%
Total	39	78.0%	11	22.0%
P-value = 0.048*				

Organisms are found to be equally distributed irrespective of diabetes status except for Pseudomonas and Staphylococcus, which are observed more in Diabetic people. Out of Amputation done patients, E. Coli and Staphylococcus are commonly observed organisms.

Table 9: Antibiotics administration in study participants

Sensitivity	Frequency	Percent
Amoxicillin + Clavulanic acid	9	18.0
Amikacin	2	4.0
Ampicillin	2	4.0
Cotrimoxazole	3	6.0
Ciprofloxacin	3	6.0
Ciprofloxacin	4	8.0
Ceftazidime	2	4.0
Gentamycin	2	4.0
Levofloxacin	7	14.0
Meropenem	6	12.0
Piperacillin and Tazobactam	9	18.0
Vancomycin	1	2.0
Total	50	100.0

Amoxicillin + Clavulanic acid, Levofloxacin, Meropenem, Piperacillin and Tazobactam are administered in most patients.

Table 10: Number of Participants in whom debridement and amputations is done

Debridement	Frequency	Percent
YES	48	96.0
NO	2	4.0
Total	50	100.0
No.of debridements		
0	1	2.0
1	1	2.0
2	17	34.0
3	18	36.0
4	9	18.0
5	4	8.0
Amputation		
YES	11	22.0
NO	39	78.0

The majority (96%) of participants received debridement. The majority had debridement more than two times the mean being 2.5. Three patients had debridement five times. 22% of patients needed amputation. People with Diabetes, PVD, albumin value < 3, duration more than seven days has a significant association with amputation being done.

Table 11: Outcome of Study participants

Outcome	Frequency	Percent
EXP	6	12.0
H	6	12.0
SH	6	12.0
SS	12	24.0
SSG	20	40.0
Total	50	100.0

12 % of the study population has expired, and the majority of patients needed Secondary Skin grafting and Secondary Suturing.

DISCUSSION

The incidence of necrotizing fasciitis has been increasing in India and around the world. Due to difficulties in diagnosis and management of this condition, it is a growing concern for health care providers. Early recognition of necrotizing fasciitis is difficult, even for experienced clinicians. The initial presentation is cellulitis, which can advance rapidly or slowly. However, differentiation of necrotizing fasciitis from cellulitis is a difficult task⁴⁰. In severe cases, the microorganisms can spread by haematogenous and lymphatic route resulting in sepsis and shock. As it progresses, there is systemic toxicity, often including high temperature, disorientation, and lethargy.

Patients with diabetes mellitus, peripheral vascular disease, compromised immunity, and a history of intravenous drug abuse are particularly at risk. These patients are at a higher risk of mortality. NF is rapidly fatal unless quickly diagnosed and aggressively treated as an emergency with repeated surgical interventions and high doses of broad-spectrum antibiotics through the parenteral route.

Awareness should be created about the risk factors and the clinical symptoms associated with necrotizing fasciitis, and affected individuals must seek medical attention immediately.

The present study has been conducted in NRI IMS on 50 patients with necrotizing fasciitis involving lower limbs and perineum admitted to this hospital over a period of 2 years from September 2019 to August 2021.

Table 12: Various studies – study centre – study place – type of study

Author	Study Centre	Place	Type of study
Present	NRIIMS	Visakhapatnam	Prospective study
Gurjit Singh et al [3]	Dr.D.Y.Patil Hospital and Medical College	Pune	Prospective study
Luca Lancerotto, Iliaria Tocco et al [4]	-	Italy	Prospective study
Roje et al [5]	University Hospital Centre	Croatia	Cross sectional study
Jason PY Cheung et al [6]	Queen Mary Hospital	Hong Kong	Prospective study
Pejman Davoudian et al [7]	West Suffolk Hospital	UK	Prospective study
Levine MG et al [8]	University of Medicine &	USA	Retrospective study

In the present study, the incidence of necrotizing fasciitis was higher in males. Around 80 % of the study population were males. A similar Indian study was done by Gurjit Singh, Pragnesh Bharpoda et al. at the Dr D.Y.Patil Hospital and Medical College Pune^[3], which also reported a higher incidence of NF in males. Another study by Maynor M et al. also showed findings similar to the present study with a male to female ratio of 3:1. However, a study was done by Luca Lancerotto, MD, Iliaria Tocco et al.^[4] done at Padova, Italy showed no sex predilection to males.

In a study by Elliot et al., the male and female ratio was 1.4:1 showing higher incidence in males. Another study by Rangaswamy M et al. also showed higher incidence in males with a male to female ratio of 4:3. The higher incidence in males is probably due to the higher addiction to smoking in the male population and may be due to the higher susceptibility of males to trauma due to their occupational exposures and alcoholism.

The majority of the patients in the present study were in the older age group, around 50 to 60 years, the mean age being 56.38±10.59 years. The increase in the incidence with age might be due to a higher occurrence of the risk factors in the older age group. This is similar to another study done in India by Gurjit Singh & Pragnesh Bharpoda et al.^[3] at the Dr D.Y. Patil Hospital and Medical College Pune, in which the most common age group is in between 40 to 60 years. In two other studies done abroad by Stone HH, Martin ID et al.^[9] the higher incidence of NF in

the older age group is probably due to the waning immunity in the older population. Cerra FB et al.^[10] reported that the most common age group is 40 to 50 years old. NF is rare among the paediatric population, which may be attributed to the lower incidence of the predisposing factors. The adult population is particularly at a higher risk of developing NF due to the higher incidence of predisposing factors. Around 58% of the study population had diabetes in this study, of which the majority were males. A study on necrotizing fasciitis done by Majeski.^[11] and co-workers in Singapore also reported a similar profile of diabetes in the study population.

Diabetes is a state of immunosuppression, which may be responsible for spreading infections in tissue planes. Further diabetic microangiopathy is well known to reduce the vascularity to the extremities, thereby favouring the spread of infection. Diabetic neuropathy further increases the risk of minor injuries to the feet, which are often the triggering factors in cases of necrotizing fasciitis. In a study done by Luca Lancerotto, MD, Iliaria Tocco et al.^[4] done at Padova, Italy, the most common predisposing risk factor is diabetes mellitus (30%).

The other predisposing factors in the study are hypertension, trauma, smoking and peripheral vascular disease. In this study, 46% of the patients had hypertension, 14% had peripheral vascular disease, 78% of the study population were smokers. In a study done by Lee CY, Kuo LT, Peng KT et al.⁵¹ done in Huang province, China, pre-existing chronic liver dysfunction, chronic renal failure,

thrombocytopenia, hypoalbuminemia represents poor prognostic factors in monomicrobial necrotizing fasciitis. In another study done by Childers BJ, Potyondy LD, Nachreiner R et al.^[12] the most common predisposing risk factors include diabetes mellitus (30%), immune suppression (17%), end-stage renal failure, liver cirrhosis, pulmonary diseases (6%), malignancy (5%).

In this study, as detected by the doppler study of the lower limbs, the peripheral vascular disease was present in around 14% of the population. The majority of the PVD patients were males (71.4%). Of all the PVD patients, diabetes was seen in 85.7%, and smoking was seen in 100%. Around 100% of the patients with PVD underwent amputation, indicating the grave prognosis of PVD, which is statistically significant.

In this study, around 78% of the population were smokers. Of the smoker's majority were male. Another Indian study done by Ramesh et al. in Delhi has had a similar incidence of smoking. In a foreign study done by Kreig et al.^[13] the major risk factor was intravenous drug abuse. However, the major risk factor in this study was smoking. This probably reflects the difference in the cultural pattern between western countries and India. Smoking was present in all the patients who underwent amputation, and this is statistically significant. All the nonsurvivors were also smokers, which is also statistically significant.

Smoking probably affects the vasculature of the study population, and the ischemia-induced due to smoking may be responsible for the poor wound healing. Smokers were at a higher risk of delayed wound healing, as indicated by the number of debridement and duration of stay in the hospital, both of which were higher in the smokers. In addition, the incidence of smoking in amputation is higher as compared to the general population.

In this study majority of the population presented with pain. Pain is present in 98% of the patients, followed by swelling of the limb seen in 84% of the patients. Discolouration was seen in 74% and fever was seen in around 70% of the population. The most common signs in this study were tachycardia seen in all the patients, tenderness in 85% of the cases 2 patients had crepitus. A group of surgeons at the Leicester Royal Infirmary have classified the skin lesions as:

Stage1: Defined with signs such as erythema, tenderness beyond the erythema, swelling, and hot skin.

Stage 2: Defined by the formation of skin bullae, blister, and skin fluctuation. Stage 3: Manifests with haemorrhagic bullae, crepitus, skin necrosis and gangrene

In an Indian study done by Gurjit Singh & Pragnesh Bharpoda, the most common symptoms included pain a (100 %), fever(100 %), and swelling (79.16 %), and the most common signs included tenderness (100 %), tachycardia (83.33 %), erythema(79.16 %) and induration (62.5 %). However, crepitus (12.5 %) was a rare finding. Wang et al.^[14] from Huang

province China have classified the symptoms into early and late manifestations.

In an Indian study involving 75 patients, 91% of patients presented with local tenderness, 99% with oedema, 72% with erythema, 73% with ulceration, and 72% with a purulent or serous discharge. Some US studies reported.^[15] that in addition to common presenting symptoms such as swelling and redness, 83% of patients had severe pain, 86% had fever, and 33% also had hypotension (systolic blood pressure, <90 mm Hg), 23% were also disorientated, and 24% experienced local anaesthesia. Rarer symptoms such as crepitus and blistering were also noted (in <40% of patients).

In this study, around 70% of the patients presented with sepsis, out of which only 46 % presented with septic shock. The majority (75%) of the patients who presented with shock presented late to the hospital. Three out of the five patients who succumbed to the illness presented in shock. Around 56.25% of the patients who underwent amputation also presented with septic shock. Another Indian study done by Gurjit Singh & Pragnesh Bharpoda reported a 22% incidence of shock in their study population. In many western nations, a score formulated by Wang et al.^[16] is being used to know the severity of NF by the name LRINEC score.

In this study patients, the mean Hb levels were 10.8 and mean albumin levels were 3.3 with anaemia and hypoalbuminemia were higher in the mortality group, which is statistically significant, indicating that these factors are poor prognostic factors in NF. In the patients who underwent amputation, anaemia was statistically significant compared to the general population. A similar study done in India.^[17] had leukocytosis (100%) followed by anaemia (66.7%) and hyperglycaemia (66.10 %) as the most commonly observed laboratory parameters; however, none were statistically significant concerning mortality. A similar study done by Wang et al.^[16] has used the LRINEC score to indicate a bad prognosis in patients with NF.

A history of minor trauma such as scratches, thorn prick or penetrating soft tissue injuries by an insect, dog bite, injections and sometimes a history of more major trauma, skin infection or ulcer may be present in patients with NF. In this study, 42% of the patients had a history of minor trauma like thorn prick. Nuwayhid ZB did a contrasting study, Aronoff DM, Mulla ZD.^[18] in Egypt have found that trauma is a significant risk factor for developing NF but not cellulitis.

Minor injuries are common in workplaces that require physical labour. Lack of proper safety precautions and bad hygiene in the workplace predispose to trauma followed by infection. The incidence was highest among the farmers, followed by unskilled labour. Following the trivial trauma, poor care for the wound is the major cause of necrotizing fasciitis. The foreign body that might get lodged due to trauma, thorn prick, or other causes forms a perfect incubator for the organisms to

flourish, complemented by lowered host defence due to alcoholism or diabetes, leading to fulminant local infection and necrotizing fasciitis. Most commonly, the disease is polymicrobial, of about 62%. The most common isolated organism is E. Coli. In this study, the most common organism isolated was E.Coli followed by streptococcus and staphylococcus aureus, Pseudomonas, Proteus, and Klebsiella constitute the rest.

In the diabetic population, E. Coli and Staphylococcus aureus are the common organisms. E. Coli is the causative organism in both people with diabetes and non- diabetics. Pseudomonas and staphylococcus are seen predominantly in people with diabetes. In the patients who underwent amputation, Staphylococcus and E.Coli are the common organisms. In all the patients infected with staphylococcus, 50% underwent amputation, denoting the increased virulence of the organism.

Necrotizing fasciitis is usually divided into two categories: Type I disease (polymicrobial) involved anaerobic bacteria and streptococci other than serogroup A, and type II disease (monomicrobial) was caused by group A streptococci (GAS).

Taiwanese studies^[19] have shown that 20 to 38% of patients had polymicrobial disease while 49 to 68% had the monomicrobial disease. Monobacterial infection was most commonly due to Streptococcus pyogenes (25% of cases). HOWEVER, in US studies, however, 71 to 75% of tissue culture isolates yielded mixed aerobic and anaerobic bacteria. A Turkish study found 82% of cases had polymicrobial infections. Worldwide, GAS was the most common pathogen responsible.

Modified from Low and McGeer et al In a similar study done by Gurjit Singh & Pragnesh Bharpoda, most infections were polymicrobial (87.5%). The most common organisms isolated included Escherichia coli (77.08%), Streptococcus (72.9 %), and Staphylococcus (50%).

Appropriate antibiotic administration is the mainstay of treatment. Most organisms were sensitive to amoxicillin-clavulanic acid, piperacillin followed by levofloxacin and meropenem in this study. In a study done by Pejman Davoudian, Neil J Flint et al.^[7] empirical therapy constituted a broad-spectrum agent such as Tazocin, containing piperacillin and tazobactam or a carbapenem, combined with clindamycin.

If Group A streptococcus alone is responsible, antibiotics may be rationalized to a combination of penicillin and clindamycin. When MRSA is suspected, Linezolid is preferred to vancomycin. In a study done by Gurjit Singh & Pragnesh Bharpoda et al, the first-line antibiotics used were intravenous crystalline penicillin, gentamicin, and metronidazole. In a study done by Seal, DV et al., 68 penicillin and clindamycin were the first-line drugs used to be treated with broad-spectrum antibiotics.

One of the most challenging aspects of necrotizing fasciitis is its similarities with cellulitis. The distinction is crucial, as cellulitis responds readily to

antibiotic treatment alone, whereas in patients with necrotizing fasciitis, survival also depends on early extensive surgical drainage and debridement, or even amputation. In addition, necrotizing fasciitis is more likely if the patient presents with a toxic appearance and/or there is crepitus and blistering. However, this is rare and usually, both conditions present with the classic inflammatory features: pain, swelling, erythema, fever, and warm skin. Investigations such as computed tomography and magnetic resonance imaging can help diagnose necrotizing fasciitis at presentation, but these imaging tools take time to process, may delay management and are expensive. Early diagnosis, aggressive resuscitation, surgical debridement, antibiotic therapy, and supportive intensive care are necessary for managing patients with NF. Aggressiveness remains the key to a successful outcome in necrotizing fasciitis. Surgical debridement is a mandatory life-saving step and should be performed as soon as possible. The importance of early surgical management has been stressed in every study. Many articles reported that the timing of first fasciotomy and debridement (within a window period of 24 hours from symptom onset) was critical in improving survival.

Wong et al.^[14] reported a nine-fold increase in mortality if the procedure is delayed more than 24 hours after hospital admission. If involved, surgical debridement must be done until brisk bleeding occurs from adjacent overlying subcutaneous tissues and underlying muscles. Repeated debridements may be necessary until the infection is adequately controlled. Some authors recommend a second surgical exploration 24 hours to 48 hours later as mandatory to ensure that the infectious process has not been extended.

In this study, the majority (96%) of the patients underwent debridement. Two patients who presented late with septic shock in the emergency expired prior to debridement. Serial debridements were primarily done in the majority of the cases in this study. The majority of the patients underwent debridement more than three times. The risk of mortality increases by 7.5 times if only one surgical debridement procedure is performed. Furthermore, primary debridement after more than 24 hours of symptom onset increases the relative risk of mortality by 9 times. The infection is rarely eradicated after a single debridement and serial debridements are almost always needed. Optimally, three debridements spaced 12–36 hours apart are required to obtain control of gross infection, according to the studies done by Pejman Davoudian Neil J Flint et al.

As quoted in certain studies, the percentage of amputations in patients with necrotizing fasciitis is as high as 33 %. In this study, 22% of the patients had an amputation. Patients with diabetes, smokers, hypoalbuminemia, Peripheral vascular disease, and those who presented late had a higher incidence of amputation. The authors recommend that surgeons aim at limb salvage surgery as long as the patient's

life is not compromised. Currently, there is no evidence to support amputation in the early stages.

Concurrent medical disease with high anaesthetic risk (poorly controlled diabetes mellitus, valvular heart disease), myonecrosis, unremitting shock, concurrent peripheral vascular insufficiency, rapidly progressive infection, a large area of tissue necrosis (heel pad and sole skin loss) are the indications of amputation in NF.

In a similar study done at Coimbatore Medical College, amputation was required in only one patient (which may be attributed to a combination of early diagnosis, aggressive debridement, and use of broad-spectrum antibiotics). In another study done by Luca Lancerotto, MD, Ilaria Tocco et al.^[4] done at Padova, Italy, amputation was rarely required for necrotizing infections of the extremities. Another study done by Ozalay M, Ozkoc G, Akpınar S et al. In Turkey.^[20] nine patients (41%) had below or above-knee amputations. In the UK, out of 451 such patients, 22.3% underwent amputation or limb disarticulation. In Taiwan, amputation was performed to control infections in 12% of patients and Hong Kong; radical debridements were performed in 46% of 24 patients. Reconstructive surgery should be considered only once the patient's general condition is stable, and the infection is fully eradicated. When not possible by secondary suturing, Wound coverage can be achieved by either split-thickness skin grafting or tissue transfer. In this study, secondary suturing was done in around 24% of cases. Skin grafting was done in 40% of the cases. In 6 patients, the raw area healed without any reconstructive procedure. Most were young males without any significant comorbidities and had a streptococcal infection. Skin grafting was the reconstructive procedure used in 22.91 % of patients in a study done by Gurjit Singh & Pragnesh Bharpoda et al.^[3] The other cases were allowed to heal by secondary intention, or secondary suturing was done. Follow-up debridement and skin grafts should be continued as needed as advised by Roje Z, Roje Z, Matic D, Librenjak et al.^[5]

The mortality rate of necrotizing fasciitis ranges from 20 to 75%. Extensive tissue necrosis may result in poor, often fatal, outcomes. Untreated, the disease is almost invariably fatal. Significant associations with adverse outcomes have been detected for many factors, like extremes of age, immunologic compromise, and systemic diseases. The main factor recognized to influence prognosis negatively is late surgical debridement. Moreover, patients with infection by Clostridia have a fourfold increased risk of death and limb loss compared with polymicrobial and other monomicrobial infections. Anaya et al.^[21] created a clinical scoring system that predicts mortality based on six independent parameters at admission:

In the present study mortality rate is around 12%. Mortality is high in patients with diabetes, patients with anaemia, hypoalbuminemia (albumin levels less than 3), presented late (more than seven days from the onset of symptoms to presentation to hospital)

and had septic shock. All these factors were statistically significant. E. coli is the most common organism cultured in these patients.

Four (33%) of 12 patients died with multi-organ failure in a US study. Admission with white cell counts exceeding $30 \times 10^9 /L$, hyperkalaemia, high partial thromboplastin times and aspartate aminotransferase levels, low arterial pH, and bicarbonate concentrations predicted mortality. A Taiwanese study showed that vibrio infections, aeromonas infections, hypotension, and malignancies were associated with a higher mortality rate ($P < 0.05$), while the presence of haemorrhagic bullae was associated with reduced mortality ($P < 0.05$). In addition, patients who died were significantly older than survivors ($P = 0.038$). In a similar study done in India at Coimbatore Medical College, the mortality rate is around 21 %.

Hence, early presentation without comorbidities like diabetes, anaemia, hypoproteinaemia, PVD are good prognostic factors. The limitations of the present study are that the relation of necrotizing fasciitis to socioeconomic status could not be adequately assessed as the hospital in which the study was conducted attended by poor people mainly. The incidence of this disease in the population could not be assessed, as the study included only patients who were admitted to the hospital.

CONCLUSION

In the present study, NF is seen most often in the older age group. Diabetes, peripheral vascular disease, smoking are significant risk factors. Pain, swelling are the most common symptoms, followed by discoloration and fever. Septic shock carries a bad prognosis, as depicted by higher amputation rates and mortality. The most common organism is E. Coli, followed by streptococcus and staphylococcus aureus; In the diabetic population, E.coli and Staphylococcus aureus are the common organisms. In the patients who underwent amputation, E.coli and Staphylococcus are the common organisms. Serial debridement is the mainstay of treatment. Patients with diabetes, smokers, hypoalbuminemia, Peripheral vascular disease, and those who presented late had a higher incidence of amputation/mortality. All the non-survivors presented with shock, and they had comorbidities. E. coli is the commonest organism cultured in these patients.

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