International Surgery Journal
Jimenez MN et al. Int Surg J. 2020 Aug;7(8):2471-2479
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20203225

Original Research Article

Necrotizing fasciitis: presentation, microbiology and outcomes in a community hospital

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Received: 29 May 2020
Revised: 11 July 2020
Accepted: 15 July 2020

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ABSTRACT

Background: Necrotizing fasciitis (NF) is an aggressive and often fatal, soft tissue infection. Delayed surgical therapy leads to worsened outcomes. This study evaluates the mortality, outcomes, and characteristics of patients with NF in a diverse New York City Community Hospital Network.
Methods: Retrospective chart review from 2012 to 2019 using ICD-9 and ICD-10 codes of gas gangrene, Fournier's gangrene, and necrotizing fasciitis was done. Of the 297 patients reviewed 28 met inclusion criteria of imaging findings, operative reports, and clinical diagnosis of NF by an attending surgeon.
Results: On average patients in ER were seen by the surgical team within less than 12 hours. Most patients were debrided within 10 hours of surgical consultation and on average received 2.2 procedures. Of the wound cultures obtained 65.38% were polymicrobial in nature. The average length of stay was 17.4 days and 32% of patients required ICU admission. The surgical mortality rate was 7.61%.
Conclusions: Necrotizing fasciitis is a rare entity and increasing provider knowledge on patient characteristics as well as the complexity of these patients and the types and number of procedures they require may help guide clinical decision making. We identified that while most of our patients had negative blood cultures on admission, those that had positive blood cultures had multiple organisms growing. Knowing that these patients are complex and likely require multiple procedures, prompt operative intervention is key.

Keywords: Community hospital, Mortality, NF, Polymicrobial, Procedures

INTRODUCTION

Necrotizing fasciitis (NF), first described by Hippocrates and introduced by Wilson in 1952, is listed in the rare disease database by the National Organization of rare disorders (NORD) with 700-1200 cases yearly in the US.[1] This aggressive, and often fatal, soft tissue infection spreads rapidly along the fascial planes causing tissue necrosis and gangrene. Collectively, terms such as necrotizing soft tissue infection, gas gangrene, Fournier's gangrene, and myonecrosis are also used to describe this condition.[2] NF typically presents with an initial soft tissue abscess and/or severe cellulitis with a rapid spread of infection, tissue necrosis, and loss of tissue planes. The aggressive nature of the disease requires prompt diagnosis as delayed surgical therapy leads to worse outcomes.[3] We present a retrospective case series of patients with NF, based on demographics, microbiology, diagnostic modalities, surgical parameters, and outcomes in a community hospital setting of a diverse borough of Queens, New York.

METHODS

A retrospective chart review of patients at our institution over a six-year period (October 2012 to March 2019) was conducted. The Institutional Review Board at our hospital approved the study prior to commencement. We queried Epic for ICD-9 and ICD-10 diagnosis codes of gas gangrene, Fournier's gangrene, NF (codes A48, L08.89, M72.6 N49.3, 728.86, 40, 608.83 codes). Using these codes, 297 charts were identified and reviewed for patient admissions and procedures. Patients were included if a clinical diagnosis of acute NF was documented by a surgical attending, with imaging findings and operative findings confirming the diagnosis. Charts that did not fulfill all three criteria were not selected. Patients who did not have a surgical procedure for whom hospice care was chosen were not included in the mortality calculation. Demographic information such as gender, age, race/ethnicity, BMI, and comorbidities were collected and de-identified. Laboratory values, imaging studies, blood/wound culture results were reviewed. The time of evaluation by emergency department physicians, the time to surgical consultation and time to operating procedures were recorded. Operative reports were reviewed. Microsoft Excel was used for calculation of averages, standard deviations and frequencies.

RESULTS

A total of 28 patients were seen and 26 met the inclusion criteria.

Table 1: Demographics and comorbidities of study population.

Demographic	N (%)
Average age	58 (24-96)
Gender	
Male	21 (75)
Female	7 (25)
Race and ethnicity	
Hispanic	12 (43)
Asian	7 (25)
Caucasian	6 (21)
African American	3 (11)
Insurance status	
Insured	21 (75)
Uninsured	7 (25)
Comorbidities	
Diabetes mellitus	17 (60.7)
Hypertension	13 (46.4)
Obesity	6 (21.4)
Intravenous drug use	3 (10.7)
Chronic liver disease	3 (10.7)
Coronary artery disease	2 (7.1)
Chronic obstructive pulmonary disease	2 (7.1)
Chronic kidney disease	1 (3.5)
Congestive heart failure	1 (3.5)

Overall 75% were male with an average age of 58.4 years and BMI of 26.9. Most patients were insured (75%), however, we did not differentiate between government or private insurance (Table 1).

The most common pre-existing comorbidities were diabetes (60.7%) hypertension (46.4%) and obesity (21.4%) (Table 1).

Table 2: Mean laboratory values of patients on admission.

Parameter	Mean±std. dev. (range)
White blood cell (count/mm^3)	19.9±11.5 (4.4-64.3)
Platelets (count/mm^3)	303±236.9 (32-1099)
Hb (g/dl)	12±2.6 (6.9-18.9)
Glucose (mg/dl)	275±223.3 (88-1090)
Na (mEq/l)	134.1±28.7 (119-144)
K (mEq/l)	4.3±0.7 (3.1-5.8)
Cl (mEq/l)	96±8.5 (36-117)
HCO_3^- (mEq/l)	21.8±15.4 (5-28)
Blood urea nitrogen (mg/dl)	28.4±12.2 (10-99)
Creatinine (mg/dl)	1.4±1.6 (0.4-3.2)
Albumin (g/dl)	3±0.6 (<0.1-4.1)
Alkaline phosphatase (U/l)	234±301.9 (18-256)
Aspartate aminotransferase (U/l)	57.1±67.5 (11-370)
Alanine aminotransferase (U/l)	50.8±43.6 (52-1576)

Hb= hemoglobin, Na= sodium, K= potassium, Cl= chloride, HCO_3-= bicarbonate

At the time of admission, the average values for white blood cell count (WBC), glucose, and alkaline phosphatase (ALP) were elevated, and hemoglobin, sodium, and bicarbonate were low (Table 2).

Blood cultures were drawn in 96% of patients and 32% (9) were positive. *Streptococcus viridans* and Group F *streptococcus* were the most common organisms isolated (Table 3). Wound cultures were obtained in 92% of patients, and 60% were positive with *Strep. viridans* in 27.5% of specimens.

Total patients that had perineum involved including those with perineum as well as extension to other sites was 10 out 28 patients or 35.7%. Total patients that had an extremity involved was 15 out of 28 or 53.6% of patients.

The majority (86%) had CT scans of the lower extremity or abdomen and pelvis (Table 4). Regarding the locations of NF, 42% were in the lower extremity and 25% in the perineum (Table 4). Including 2 patients that had lower extremity and additional location 15 of the 28 (54%), patients had lower extremity involvement.

Table 3: Blood cultures, wound cultures and antibiotic treatment.

Blood cultures	N (%)
Negative blood culture	19 (66)
Positive blood culture	9 (32)
Organisms	
Streptococcus viridans	2 (22)
Group F *Streptococcus*	2 (22)
Klebsiella spp.	1 (11)
Group A *Streptococcus*	1 (11)
Escherichia coli	1 (11)
Salmonella spp.	1 (11)
Achromobacter xylosoxidans	1 (11)
Wound cultures	
Positive wound culture	
Streptococcus viridans	8 (27.5)
Group B *Streptococcus*	5 (17.2)
Group A *Streptococcus*	3 (10.3)
Group F *Streptococcus*	2 (6.9)
Escherichia coli	2 (6.9)
Coagulase-negative *staphylococcus*	2 (6.9)
Klebsiella spp	1 (3.4)
Methicillin-resistant *Staphylococcus aureus*	1 (3.4)
Group C *Streptococcus*	1 (3.4)
Staphylococcus aureus	1 (3.4)
Negative wound culture	1 (3.4)
No wound culture	2 (6.9)
Antibiotics	
Vancomycin	24 (36.4)
Zosyn	16 (24.2)
Clindamycin	12 (18.2)
Flagyl	2 (3.0)
Merrem	3 (4.5)
Fluoroquinolone	3 (4.5)
Antifungal	2 (3.0)
Daptomycin	1 (1.5)
Ertapenem	1 (1.5)
Primaxin	1 (1.5)
No antibiotics (CMO)	1 (1.5)

Table 4: Imaging and localization of NF.

	N (%)
Imaging modality	
CT of lower extremity OR abdomen/ pelvis	24 (85.7)
Ultrasound testes	2 (7.1)
X-ray of extremity	1 (3.5)
X-ray and MRI	1 (3.5)
Locations	
Lower extremity only	13 (46.4)
Perineum	8 (28.5)
Abdominal wall	3 (10.7)
Perineum and bilateral flanks	1 (3.6)
LE and abdominal wall	1 (3.6)
Back/psoas muscles	1 (3.6)

We report that 69% (18/26) of our patients were taken to the operating room in less than 10 hours from the time of surgical evaluation (TOSE) with an average time to the operating room (TTO) of 3.6 hours (Table 5).

Table 5: Timing, surgical management and disposition.

Time to surgical consultation (TTSC) and time to operating room (TTO)	N	Mean±SD. (range) hours
TTSC	28	18.5±39.6 (0.7-178)
TTO	26	11.7±16.2 (0.8-221)
ED		
TTSC	16	3.9±3 (0.7-10)
TTO	15	12.6±19 (0.8-70)
TTO (no delay)	18	3.6±2.9 (0.7-10)
Floor		
TTSC	12	37.5±49.1 (6.8-178.7)
TTO	11	28±65 (0.8-221)
Types of procedures		**N (%)**
Excisional debridement		35 (50.7)
Incision and drainage		22 (32)
Amputation		6 (8.7)
Wound revision/closure		5 (7.2)
Colostomy		1 (1.4)
Location of disposition		**N (%)**
Home		13 (46.4)
Nursing home		10 (35.7)
Hospice		3 (10.7)
Deceased		2 (7.1)

An average of 2.2 procedures were done per patient with an average hospital length of stay (LOS) of 17.6 days.

Intensive care unit (ICU) admission was required for 32% (9 patients) and surgical mortality was 7.7% (2 patients).

DISCUSSION

NF is a type of necrotizing soft tissue infection, as necrosis may extend beyond the fascia, involving the muscle, skin, and surrounding tissues.[4] The operative findings are usually described as “dishwater fluid” and dissection of fascial planes by an infectious process. Similar terms were used in the operative notes of our patients. Giving the rapid progression of NF, an early diagnosis must be obtained. Misdiagnosis may occur in 75% of cases as recognized by Goh et al.[5] In NORD’s rare disease database, it was stated that “doctors are expected to see two cases of NF in their lifetime”.[6] Many authors have pointed out that preadmission antibiotics, non-steroidal anti-inflammatory agents, and steroids can modify the initial clinical picture and mask the severity of the underlying infection.[7]

Early symptoms of NF may be mistaken for the flu, including high fever, sore throat, abdominal pain, nausea, diarrhea, chills. Later patients develop pain out of proportion to a physical exam with or without erythema, bullae, soft-tissue edema, rapid progression of local infection to systemic shock. Goh et al have described the pain as "tenderness extending beyond the apparently involved area owing to enzymes and toxins spreading along the fascia below the skin, making the margins of involvement indistinct".[5] Clear blisters (bullae) represent an intermediate stage between early and late NF with skin necrosis. The positive 'finger test' with infiltration of local anesthesia down to the fascia, refers to "the index finger dissects the subcutaneous tissues off the deep fascia easily along the tissue plane". In our study, the average time from onset of symptoms to presentation in the ED was six days.

Necrotizing fasciitis location

The location of the NF varies, most frequently affecting extremities and then perineum, described as Fournier's gangrene, and rarely the trunk. In our study, 53.7% of NF had a lower extremity involvement (Figure 1) and in 35.7% it was the perineum. The abdominal wall was a site in 10.7% of our cases and the remainder were atypical locations (Table 4).

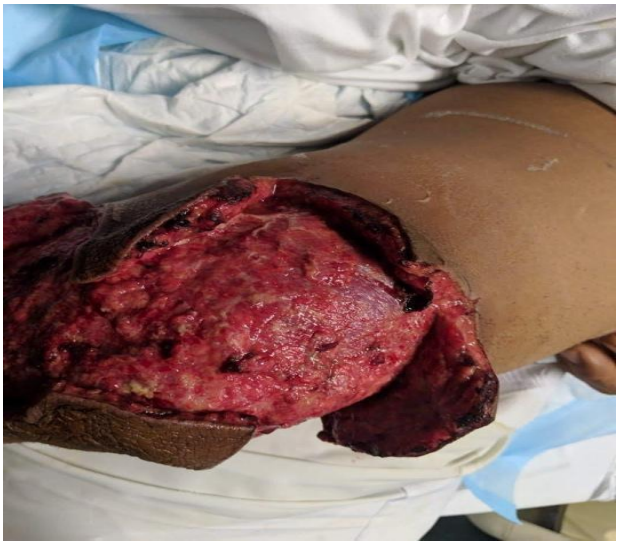

Figure 1: 41-year-old diabetic patient 2 days post-op after an extensive debridement of the lower extremity. Some granulation tissue is present.

One of our patients had perforated diverticulitis, with subsequent abscess formation penetrating the abdominal wall and dissecting tissue planes (Figure 2). Underwood et al. reported a case of a 51-year-old male with perforated diverticulitis spreading to the retroperitoneum and tracking into the lower extremity, who required a hip disarticulation.[8] One of our patients had an extension of Fournier's gangrene to bilateral flanks requiring extensive debridement of the perineum (Figure 3).

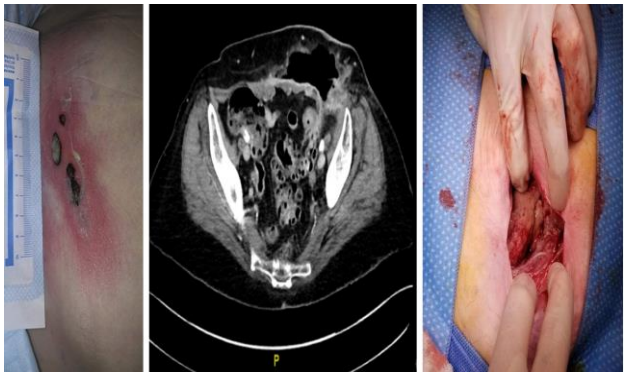

Figure 2: A 75-year-old female presented with abdominal wall abscess, erythema of the skin and an eschar (left). A bedside incision and drainage was done which appeared superficial. Subsequently, a CT pelvis demonstrated an abdominal wall necrotizing fasciitis secondary to a smoldering perforated diverticulitis (middle). Patient underwent mini laparotomy and washout, here the fascia is visible with underlying necrotic fatty tissue (right).

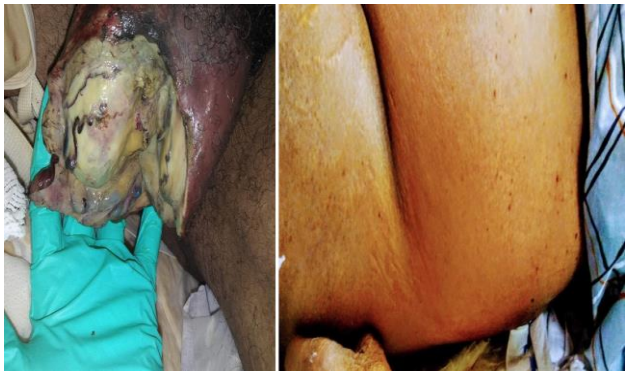

Figure 3: A 54-year-old diabetic male patient with Fournier's gangrene after debridement of the perineum (left). His infection progressed and although it appeared very subtle, an ascending erythema as shown in the flank, accompanied by warmth of the skin prompted a repeat CT scan. This led to the diagnosis of bilateral ascending NF which required an extensive debridement of the perineum and both flanks.

Two abdominal NF cases occurred in nursing home patients a week after percutaneous gastrostomy (PEG) tube placement. One patient underwent emergent surgery, required ICU admission, and survived. The family of the second patient requested comfort measures and declined surgical intervention. In the literature, fatal complications of PEG placement are rare. In conjunction with typical findings of cellulitis such as induration, erythema, and tenderness, any additional findings of excessive pain on the exam, palpable crepitus, or bullae should be highly suspicious for NF in these patients.[9] Subcutaneous emphysema is present on abdominal x-ray and CT scan, and fat stranding in the abdominal wall soft tissue extending to subcutaneous fat may be seen.[10,11] Both of our patients had the exam and radiographic findings described above (Figure 4).

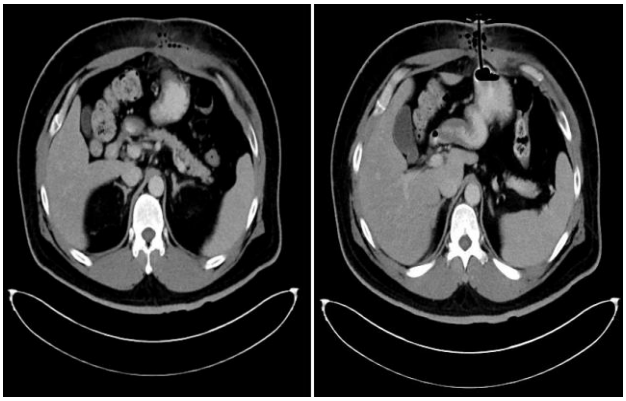

Figure 4: A patient with necrotizing fasciitis secondary to infected PEG. CT Abdomen/Pelvis demonstrating air in the subcutaneous tissue as well as the anterior sheath of the abdominal wall with inflammatory changes in a patient 1 week after PEG insertion.

One patient presented a one-week post-cesarean section, with an abdominal wall NF and septic shock. She underwent an abdominal wall debridement followed by an emergent hysterectomy. A series of 23 patients with NF after a cesarean delivery showed a mortality of 13% despite the patients being operated on within 48 hours of diagnosis.[12] Interestingly one diabetic patient had two separate concomitant sites of NF, in the lower extremity and the perineum, requiring a below the knee amputation and multiple extensive perineal debridement.

Imaging findings

Gas in soft tissues on plain radiographs may help in the diagnosis of NF in unstable patients.[4] CT scans show inflammatory changes along fascial planes, submuscular or subfascial abscesses, and cellulitic changes. Sonographic findings of NF include diffuse thickening of subcutaneous tissue, accompanied by a layer of fluid accumulation more than 4 mm in depth along with the deep fascial layer (Figure 5).

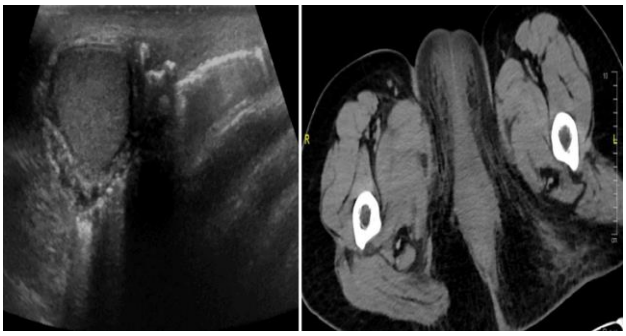

Figure 5: Fournier's gangrene in the male: an ultrasound of the testes showing gas and fluid collection in the surrounding soft tissue (left). In a female: CT pelvis after an episiotomy (right).

These findings, when compared with the contralateral position on the corresponding normal limb, show 88% sensitivity, 93% specificity, and 91% accuracy.[13] On T2 weighted MRI, NF presents with a greater thick signal intensity and focal non-enhancing areas of abnormal signal intensity in the deep fascia.[4] Our patients with NF all received preoperative imaging studies with 81% undergoing a CT scan of the lower extremity or the abdomen and pelvis (Table 4).

Laboratory features

The laboratory risk indicator for NF (LRINEC) score includes leukocytosis, elevated plasma glucose, low sodium, high creatinine, high C-reactive protein, and low hemoglobin. It has been used to determine low risk (<6), moderate risk (<8), severe risk (≥9). In 2016, Sander et al found an LRINEC ≥6 to have a PPV of 92%.[14] Nevertheless, the LRINEC Score has been challenged. In a prospective study of 106 patients with NF and 825 with cellulitis, Hsiao et al pointed out that LRINEC scores may not be an accurate tool to differentiate between severe cellulitis and NF in the ER setting.[15] We did not have an LRINEC score calculated as, in the earlier years of our study, CRP levels were not drawn systematically. However, most of our patients did present with leukocytosis, hyponatremia, and hyperglycemia. Like Tuncel et al. we noted an elevated alkaline phosphatase in the majority of patients (Table 3).[16]

Comorbidities

Diabetes, obesity, cirrhosis, hypertension, peripheral vascular disease, cancer, steroids, smoking, alcohol have all been described as accompanying conditions in patients with NF.[5] Goh et al. in their 33-year research (January 1980-March 2013) compiled 9 studies in different countries including USA, New Zealand, Singapore, India, Taiwan, and found that among the 1463 patients collected 44.5% of them had diabetes.[5] Liver disease contact with marine life, or ingestion of seafood were also considered as risk factors in Asia. NF has also been described in previously healthy young patients. Waldron et al cautioned to consider intravenous drug abuse (IVDA) as a risk factor for increased admission of NF cases.[17] Esayag et al emphasized that NF in pressure ulcers is under-diagnosed and rarely reported with a progressive, unpredictable, often devastating course.[18] Diabetics comprised 60.7% of the patient pool in our study (Table 1).

Microbiology

In 20-30% of cases, no definitive cause can be found.[1] In a large meta-analysis, Goh et al demonstrated that positive results occur in wound culture in 76.5% of cases, but only in 35% of blood cultures.[5] Polymicrobial infections makeup 80% of infections and are classified as type 1 NF. These are caused by gram-negative rods, gram-positive cocci, (GAS: Group A *streptococcus* and *staphylococcus*), and anaerobes. Type 2 monomicrobial isolates include *Streptococcus pyogenes* and *Clostridium*

perfringens. Type 3 usually secondary to *Vibrio* species which are found in brackish waters and patients injured during aquatic activity should raise suspicion. Type 4 is generally associated with trauma and fungi.[4]

Tsung-Yu et al caution that gram-negative monomicrobial NF is associated with chronic kidney disease, cerebrovascular disease, septic shock, low fibrinogen level, lactate higher than 2 mmol/L.[19] The wound cultures obtained demonstrated that the majority of patients had a polymicrobial infection, similar to our study which represented 65.3% of our positive cultures (Table 3). The microbiology of NF seems to depend on the region of the world it is seen. For example, in Taiwan monomicrobial infections predominate.[20,21] However, in the United States, polymicrobial infections are more frequent.[22] The main causative microbes identified in our wound cultures were *Streptococcus viridans* (27.5%), Group B *streptococcus* (17.2%), and Group A *streptococcus* (10.3%). It should be noted two patients had yeast-like organisms that are rarely described (Table 5). Other organisms isolated in blood and wound cultures include *Escherichia coli*, Coagulase-negative *staphylococcus*, Methicillin-Resistant *Staphylococcus aureus*, Group C *streptococcus*, *Salmonella spp*. and atypical organisms such as *Achromobacter xylosoxidans* and *Morganella morgagni* and *K. Ohmeri*.

Evaluation and treatment

There have been no randomized controlled trials studying timing, the extent of surgical therapy, and the definition of "adequate debridement".[4] Wong et al showed that a delay before surgery of more than 24 hrs correlated with higher mortality.[5,7] Misiakos et al in a study of 62 patients over 10 years, stressed that diagnosis should be obtained within 4 hours of admission, with 12.8 hr. to treatment on average, and up to 5 repeat debridements.[23] Sander et al found in the 2106 largest European study of 58 patients over 10 years, that 67% were operated within 24 hours of admission with 2.8 debridements, and a mortality of 29.3%.[14] Mock et al showed that the relative risk of death was 7.5 times greater in cases of restrictive primary debridement.[24]

In our study, 16 ED evaluations were conducted during the daytime, 10 during night-time with an equal number of surgical evaluations done on each shift.[25] There were 11 surgeons who operated in our NF cases, with 2 of them treating 53% (7 each) of the cases, and the remainder treating 2 to 4 cases over the years. Most surgical consults occurred in the emergency department (ED), however, some were admitted to the medical floor prior to surgical consult requests. Time to surgical evaluation was defined as the time from evaluation by ED providers to time of surgical evaluation (TTSE).[26,27]

In consults requested while in the ED, the time to surgical evaluation (TTSE) in 53.7% of patients was on average 3.9±3 hours. There were 13 patients consulted after inpatient admission to the medical service and their average TTSE was 38.8±51.3 hours. Delays in consulting most often came from presumed diagnosis of cellulitis or abscess, inconclusive initial imaging findings with subsequent progression of the disease, or new imaging prompting surgical evaluation.

Time to OR (TTO) was defined as the time from surgical evaluation to the operating room.

69.3% (18/26) patients were taken to the operating room in less than 10 hours with an average TTO 3.6 hours. Time to OR from surgical consultation was similar in both day and night shifts. For the patients initially admitted to the floor (30.7%), the average TTO was 28.0±65. Reasons for the delay to the operating room from the time of surgical evaluation (TTSE) included the need for correction of severe electrolyte abnormality, medical management of concurrent medical conditions for preoperative optimization, and progression of the disease initially thought to be superficial. Two outlier cases were admitted to the medical service and podiatry was consulted first. The surgical evaluation was requested after the patient's disease progressed past the foot (TTSE 178 hours and 221 hours respectively). The first patient required an amputation and the second an incision, drainage, and extensive debridement.

Adjunct therapy

The antibiotic coverage in NF targets gram-positive organisms, anaerobes, and gram-negatives. There are no studies to determine the length of their use, but most are continued until no further debridement is required.[28-30] In our study, Vancomycin was the most frequent antibiotic prescribed (88%) in combination with Zosyn (53%), and in the remainder with clindamycin or Unasyn, Ciprofloxacin, Flagyl. Antifungals were used in two patients. In general antimicrobial therapy should be tailored to the cultures and gram stain but empiric therapy should include a broad spectrum penicillin and an agent that has good anaerobic coverage such as metronidazole or clindamycin.[1,31-33] Given the nature of this disease prospective studies evaluating the efficacy of one type or antibiotics versus another is not feasible but starting with broad spectrum coverage should be considered in most cases.[34-37] WJES clinical guidelines on soft tissue infections recommend broad coverage with an anti-MRSA agent as well as broad gram negative coverage. They advocate for Linezolid as a drug of choice in empiric coverage.[38]

The utility of hyperbaric oxygen therapy has not been proven but in a study of 1683 NSTI cases at 14 hyperbaric centers, it was associated with a survival benefit when used in conjunction with other treatment modalities in the sickest patients.[25] Hyperbaric therapy was not used in our study. Negative pressure wound therapy (VAC), initially described by Argenta and Morykwas in 1997, is effective in controlling tissue

edema, preventing colonization of pathogens, promoting angiogenesis and growth, and can be used in NF postoperatively.[26] When VAC was compared to wet to dry dressing, the daily cost was $100 per day versus $15 per day. The time spent doing the dressing was 4.8 minutes compared to 18 minutes, resulting in a faster and more significant change in the dimension and volume of the wound.[27] In our study, VAC was used in 46% of patients, with an average duration of 12.5 days. Figure 12 shows a post-operative wound utilizing a wound vac.

Insurance and length of stay (LOS) and disposition

Our assumption that NF occurs more in the uninsured, due to delayed diagnosis was not verified, as only 21.4% of our patients were uninsured. Patients who survive still experience prolonged hospitalization for wound care and reconstruction. Interestingly, the Combined urology and plastics index (CUPI) score was created to help predict the length of stay in patients with NF involving the perineum.[28] It combines age, BMI, bicarbonate, hematocrit, calcium, alkaline phosphatase, albumin, lactate, blood urea nitrogen, INR, and bilirubin. A score of less than 5 predicts a LOS of 25 days, and with higher than 5, it amounts to 71 days. Sander et al in the European study found a mean duration of hospitalization of 46 days in patients who survived, with a mean ICU stay of 11 days.[14] Patients often require an ICU admission, in our study 32% stayed in the surgical intensive care unit, with an average ICU stay of 2.3 days. Our hospital LOS of 17.4 days was most often linked to an uninsured status and difficulty in obtaining charity wound services while 46% of our patients went home.

Mortality

NF has annual mortality of 4.8 per 1,000,000 person-years.[29] In the US. Blacks, Hispanics, and minority individuals are disproportionately affected and tend to have a worse prognosis.[2] The CDC's most recent NF mortality rate is 15-33%.[36] In 2013, Faraklas et al quoted mortality of 13% and worked on the development and validation of necrotizing soft tissue infection mortality risk calculator using NSQIP.[30] The criteria included: age >60, partially dependent functional status, hemodialysis, ASA-4, emergent surgery, septic shock, and low platelets*. The Fournier gangrene severity index (FGSI) created in 1995, used in NF of the perineum, including temperature, heart rate, respiratory rate, sodium, potassium, hematocrit, leucocytes, bicarbonate, is a mortality predictor cited in the literature.[32] New studies showing rates of 12-25%.[22,31,32] It is well known that early surgical intervention is a predictor of improved mortality.[31,32]

A retrospective study by Khamnaun et al out of Thailand included 1,504 patients who had a mortality of 19.3%.[33] Golger et al published a cohort of 99 patients in Canada showing a mortality of 20%.[34] They determined predictors of mortality to be advanced age, toxic shock syndrome, and immunocompromised status. Huang et al showed an increased risk of death in patients that were older than 60 years and a creatinine >2.0.[25] Anaya et al conducted a study in the United States of 136 patients with NF and demonstrated a mortality rate of 16.1%, and that clostridial infection was associated with higher mortality.[22] Our surgical mortality was 7.7%, (2/26) in a patient sample that was majority Hispanic and Asian. The first patient presented four days after vaginal delivery with an infected episiotomy wound, Fournier's gangrene, and septic shock. CT imaging is shown in Figure 5. The surgical consult was called 24 hours later and despite debridement within 3 hours of the consult, she died. The second patient was a 69-year-old male with congestive heart failure (CHF), diabetes, sepsis, and lower extremity NF who refused the amputation proposed initially. He succumbed after a delayed procedure which he finally accepted more than 24 hours later.

Ethnicity, race, insurance coverage did not negatively affect mortality, the number of procedures, or time to operate in our study. Both of these patients received surgical care beyond the expected TTSE and TTO. It is important to note that there were two patients for whom their families chose comfort care, hence they were not included in our surgical mortality.

This study has several limitations innate to retrospective chart reviews. Many patients who may have been admitted with NF may not have had appropriate documentation by ICD code, and thus may have been missed from the initial electronic medical record search. Evaluating a rare disease, we expected to have a small sample size (28 patients), however, this limits the translatability to a larger population. The sample size was also limited to one institution, although 11 surgeons were involved in these patients' care.

CONCLUSION

NF is a rare but highly morbid disease entity. Increasing ED provider awareness of varied presentations and complexity of care will prompt earlier surgical consultation. Regardless of ethnicity and case mix index and severity, especially in an aging population with multiple comorbidities, delay in time to surgical consultation and time to operation can occur when patients are admitted to a non-surgical service. A high index of suspicion and timely surgical intervention, with repeated debridements, and early ICU admission, can minimize the morbidity and mortality of necrotizing fasciitis. Multi-centered studies of this entity in the United States will help to create an evidence-based assessment and management algorithm.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Jimenez MN, Seltzer ES, Devanabanda B, Louis M, Mandava N. Necrotizing fasciitis: presentation, microbiology and outcomes in a community hospital. Int Surg J 2020;7:2471-9.