Necrotizing fasciitis (NF) is a predominantly adult disorder with bacterial infection of the soft tissue. In children, it is relatively rare and has a fulminating course with a high mortality rate. In the neonate, most cases of NF are attributable to secondary infection of omphalitis,1,9 balanitis,1,8,10 mammitis,1,11 postoperative complications,2,12–14 and fetal monitoring.15 The objective of this communication is to report 3 cases of neonatal NF and provide a literature review of this disorder.

**Case Reports**

**Case 1**

A full-term, 13-day-old female infant, weighing 3891 g, was admitted to the hospital because of fever and irritable cry. She was born after an uncomplicated pregnancy and delivery. Physical findings on admission included an extensive erythematous, edematous, and tender area over the lower back (Fig 1A). No puncture wounds, omphalitis, or other skin rashes were noted. The skin lesion extended rapidly to both flanks and the affected skin became violaceous in color (Fig 1B). The laboratory findings showed a leukocyte count of 8000/mm³ with 6% bands, 71% segmented neutrophils, 15% lymphocytes, and 8% monocytes. The platelet count and serum electrolyte values were within normal limits. The C-reactive protein level was 104 mg/L (normal <5 mg/L). Ultrasonography of the affected area revealed thickened fascial plane and fluid accumulation between subcutaneous fat tissue and muscular layer (Fig 2). Extensive excision with debridement of necrotic subcutaneous tissue and fascia was performed on the third hospital day. The blood and wound cultures yielded oxacillin-resistant *Staphylococcus aureus*. Antibiotic therapy including oxacillin, gentamicin, and metronidazole were given initially, and were changed to vancomycin to be consistent with the results of cultures. There was no sign of osteomyelitis on radiographic examination of the lumbar area. Skin grafting with scalpel for coverage of the debridement wound was performed on the 22nd hospital day. The patient was discharged well with good eschar formation approximately 1 month after admission.

**Case 2**

A full-term, 16-day-old female infant, weighing 4298 g, was admitted with extensive inflammatory lesions over the lower back and buttock. Fluctuation was also noted in the affected areas. The family did not notice other skin lesions or trauma. The patient did have a maximum temperature of 39.8°C 2 days before admission. On admission, the leukocyte count was 16 500/mm³ with a differential count of 0.5% myelocytes, 1.5% metamyelocytes, 11.5% bands, 61.5% segmented neutrophils, 14% lymphocytes, 9% monocytes, and 2% eosinophils. The platelet count and serum electrolyte values were normal. The C-reactive protein level was 284 mg/L. Computed tomography scan of lumbosacral region showed increased soft tissue density with obliteration of subcutaneous fat plane at the back (Fig 3). An emergency surgical debridement was performed 3 hours after admission. Wound cultures were positive for oxacillin-resistant *Staphylococcus aureus*. Oxacillin, gentamicin, and metronidazole were given immediately after her admission, and were changed to vancomycin following wound cultures results. Blood cultures were sterile. A second debridement and skin flap closure with retension suture were performed 5 days after admission. The final definitive skin coverage was achieved using a local flap. The patient was discharged well with good eschar formation approximately 1 month after admission.

**Case 3**

A full-term, 15-day-old female infant, weighing 3500 g, was admitted with an extensive erythematous, edematous, and tender area over the thorax (Fig 1C). On admission, the leukocyte count was 14 200/mm³ with 61% segmented neutrophils, 9% bands, 1.5% metamyelocytes, 18% lymphocytes, and 3% monocytes. Blood and wound cultures yielded *Staphylococcus aureus*. They were treated initially with oxacillin, gentamicin, and metronidazole. On hospital day 2, the patient was discharged well with good eschar formation approximately 1 month after admission.
performed 2 weeks later. She was discharged well with good eschar formation from the hospital 25 days after admission.

Case 3

A full-term, female infant, weighing 3500 g, was delivered at term after an uneventful delivery. She was admitted to our hospital at 7 days of age because of fever, poor feeding, and a large erythematous, indurated area in the lumbar region. The leukocyte count was 17 700/mm³ with a differential count of 1% metamyelocytes, 20% bands, 59% segmented neutrophils, 13% monocytes, and 7% lymphocytes. The serum electrolyte values and the platelet count were normal. The C-reactive protein level was 128 mg/L. Ultrasonography of the affected area on the back revealed fascial thickening and echolucent band (similar to Case 1). Fasciotomy with debridement of necrotic subcutaneous tissue and fascia was performed within 9 hours after admission. The wound culture yielded oxacillin-resistant *Staphylococcus aureus* and the blood culture was sterile. Oxacillin, gentamicin, and metronidazole were given initially, and were changed to vancomycin when the wound cultures results were available. She was discharged on the 29th hospital day in good condition. The skin healed well without skin grafting.

REVIEW OF LITERATURE

Our literature review yielded 66 cases of NF for analysis (Table 1).1–20 Only 3 cases were premature.5,12,18 There was no sex predilection and the condition rarely recurred.11 Several underlying conditions were identified that might have contributed to the development of necrotizing NF. These
included omphalitis in 47,1–9 mammitis in 5,1,11 bal-
anitis in 4,1,8,10 fetal scalp monitoring in 2,15 post-
operative complications in 2,13,14 septicemia in 2,17,18
and necrotizing enterocolitis,12 immunodeficien-
cy,16 bullous impetigo,19 and maternal mastitis20 in
1 patient each.

The most common site of the initial involvement
was the abdominal wall (n = 53), followed by the
thorax (n = 7), back (n = 2), scalp (n = 2), and
extremity (n = 2). The initial skin presentation
ranged from minimal rash to erythema, edema, in-
duration or cellulitis. The lesions subsequently
spread rapidly. The overlying skin might later de-
velop a violaceous discoloration, peau d’orange ap-
pearance, bullae, or necrosis. Crepitus was uncom-
mon.20 Fever and tachycardia were frequent but not
uniformly present. The leukocyte count of the per-
ripheral blood was usually elevated with a shift to
the left. Thrombocytopenia was noted in half of the
cases. Hypocalcemia was rarely reported.20

Of the 53 wound cultures available for bacterio-
logic evaluation, 39 were polymicrobial, 13 were
monomicrobial, and 1 was sterile. Among the 39
specimens with polymicrobial infections, the pre-
dominant aerobic bacteria were *Staphylococcus au-
reus*, *Escherichia coli* and enterococcus, whereas the
predominant anaerobic bacteria were *Clostridium* spp
and *Bacteroides* spp. *Staphylococcus aureus* was the
most common organism recovered from the wound
cultures with monomicrobial infections. Blood cul-
ture was positive in 20 cases (50%) including 5
polymicrobial and 15 monomicrobial bacteremia,
and sterile in 20 cases. Bacteremia caused by organ-
isms identical to those found in the wound cultures

![Fig 2. Case 1.](attachment:image1.png)

**Fig 2.** Case 1. Ultrasonography of the affected area revealed thickened fascia (arrows) with fluid accumulation.

![Fig 3.](attachment:image2.png)

**Fig 3.** Case 2. CT scan showed increased soft tissue density with obliteration of subcutaneous fat plane (arrows) in the lumbosacral region.
TABLE 1. Clinical Features of Neonatal Necrotizing Fasciitis

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference No.</th>
<th>Year of Report</th>
<th>Number of Cases</th>
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* Other associated factors included necrotizing enterocolitis,12 postoperative complication,13,14 fetal scalp monitoring,15 immunodeficiency,16 septicemia,17,18 bullous impetigo,19 and maternal mastitis.20
† Three other patients were included in an earlier report.1
‡ The location of initial involvement included both of the lower abdomen and groin area in 4 cases after circumcision.
occurred in 13 instances. Two blood cultures and one wound culture grew *Candida* species.5,16

Treatment modalities included the use of antibiotics, supportive care, surgical debridement, and drainage of affected fascial planes. Two of the 6 cases who received hyperbaric oxygen therapy died.8,10 The overall mortality rate was 59% (39/66). Death usually occurred before surgery or shortly after surgical intervention as a result of bacterial infection with septic shock, disseminated intravascular coagulation, and/or multiple-organ failure. In 12 cases, skin grafting was required because of poor granulation formation or large postoperative skin defects among the survivors.38–40

**DISCUSSION**

NF is primarily an adult disease. It was first described in detail in 1924 by Meleny.21 The term “necrotizing fasciitis” was introduced by Wilson in 1952 when he observed a rapidly progressive inflammation and necrosis of subcutaneous tissue, superficial fascia, and superficial part of the deep fascia with variable presence of cutaneous gangrene.22

Among neonates, NF frequently was attributable to secondary infection, such as omphalitis,1–9 mastitis,11 balanitis,12 postoperative complications,13,14 fetal scalp monitoring,15 and bullous impetigo.16 Other associations of NF included necrotizing enterocolitis,12 immunodeficiency,16 and sepsis.17,18 Primary NF, which implies lack of a known causative factor or any identifiable portal of entry for bacteria, is rarely reported in the neonate. Although there were no known causative factors in our patients, there may be unrecognized infections in the epidermis with systemic bacterial invasion in these relatively immunocompromised neonates. Thus, we cannot be certain that our cases are primary necrotizing fasciitis.

In the neonate, the site of involvement is usually dependent on the etiologic factor. For instance, when the causative factors are omphalitis and balanitis, the site of involvement is usually the abdominal wall. In cases of mastitis and fetal monitoring, the thorax and the scalp are sites involved, respectively. In 5 cases, including our 3, the inflammation began in the lumbar regions.

It is important that early diagnosis is made for NF because immediate surgical debridement offers the best chance for survival. Because of the variable changes of skin presentation and nonspecific laboratory findings in the early stage of the disease, prompt diagnosis is often difficult and relies on a high index of suspicion. Marked tissue edema, rapid progression of inflammation, and signs of systemic toxicity are the diagnostic clues. Ultrasonography,23 computed tomography,24 and magnetic resonance imaging25 have been very useful in the diagnosis of NF. Stamenkovic and Lew26 had suggested that immediate surgical exploration with frozen section biopsy may provide definite and life-saving diagnosis in questionable cases. However, because necrosis is present at the junction between the subcutaneous tissue and fascia, definite diagnosis is usually made at surgery by demonstration of a lack of resistance of normally adherent fascia to gentle finger pressure or blunt probe dissection.27,28

Because wound cultures were predominantly polymicrobial (39 cases, 73.6% in our review), Moss et al29 had recommended that the antibiotic therapy should be a combination of penicillin or a cephalosporin for Gram-positive, an aminoglycoside for Gram-negative, and clindamycin or metronidazole for anaerobic organism. However, because some cases are monomicrobial such as ours, it is important to retrieve wound cultures results as promptly as possible so that appropriate antibiotic therapy can be instituted. McHenry et al29 demonstrated that a prolonged lapse time between hospital admission and operative debridement was the only potential determinant associated with an unfavorable outcome in NF. It is important that prompt adequate surgery be performed. The procedure should include early debridement of all necrotic tissue and drainage of affected fascial plane by extensive fasciotomy until viable bleeding tissue is encountered.1,27,29

Supportive care consists of aggressive fluid resuscitation and pain control.27 Hyperbaric oxygen therapy has been used, however, Brown et al30 in a retrospective review showed that this therapy did not reduce mortality or the number of surgical debridements in the treatment of major truncal NF. A prospective study of hyperbaric oxygen therapy is mandatory to clarify the role of this therapy as an adjunctive measure in the management of NF.

**CONCLUSION**

Neonatal NF is an uncommon but often fatal bacterial infection of the skin, subcutaneous fat, superficial fascia, and deep fascia. Clinically, it is characterized by marked tissue edema, rapid spread of inflammation, and signs of systemic toxicity. It is usually a polymicrobial infection in secondary NF and the location of initial involvement depends on the underlying etiologic factor. High index of suspicion, prompt aggressive surgery, appropriate antibiotics, and supportive care are the main stays of management in the newborn infant with NF.

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**REFERENCES**


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