



Abstract

Necrotizing fasciitis (NF) is a life-threatening, rapidly spreading bacterial infection of the soft tissues, characterized by necrosis of the fascial planes and surrounding structures. This case series describes the presentation, diagnostic findings, treatments, and outcomes for 4 dogs for which a diagnosis of NF was strongly suspected. Definitive diagnosis is difficult to achieve before surgical intervention is needed. Delays in recognition will lead to an advanced state of clinical disease, resulting in poor outcomes. Despite aggressive medical management, including intravenous antibiotics, the mortality rate for dogs with NF is 100% in the absence of surgical intervention.



EMERGENCY MEDICINE/CRITICAL CARE

Case Series: Necrotizing Fasciitis in 4 Dogs

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Necrotizing fasciitis (NF) is a rapidly progressive, life-threatening bacterial infection of the subcutaneous tissues, fascia, and occasionally skeletal muscle. The most common causative bacterium is β -hemolytic *Streptococcus canis*, a group G *Streptococcus* species. Other reported causes include *Staphylococcus pseudintermedius*, *Staphylococcus aureus*, *Pasteurella multocida*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Serratia marcescens*.¹⁻⁴ Predisposing factors, although not always evident, are minor trauma, blunt force trauma, and immunocompromised states.¹⁻⁵

In dogs, the most common signs of NF are rapidly progressive swelling, lameness, and hemorrhagic skin pigmentation (often progressing from red to purple to black). Most common is cutaneous involvement of the limbs and neck; however, the trunk can also be involved (**FIGURE 1**).^{4,6-8} During the early stages of NF, dogs often exhibit extreme pain that is disproportionate to the outward appearance of their lesion and then rapidly progress to having septic shock.⁶ Multiple organ dysfunction syndrome, disseminated intravascular coagulation (DIC), and shock leads to death in 70% to 80% of dogs with NF.⁹ Prompt and aggressive surgical intervention, including debridement,

Take-Home Points

- Clinical suspicion for necrotizing fasciitis (NF) should be raised by mounting pain, swelling/edema, and cutaneous bruising in combination with signs of septic shock.
- Although not pathognomonic for NF, soft wisps within the subcutaneous space seen on radiographs or subcutaneous edema with thickened fascial planes noted during ultrasonography in a systemically ill patient should make NF a differential diagnosis.
- Clinicians with a high degree of suspicion for NF should recommend immediate surgical intervention after the dog is hemodynamically stable.
- The preferred antibiotics for NF are β -lactam and β -lactamase inhibitors, including high-dose penicillins, carbapenems, and clindamycin. Fluoroquinolones are not recommended.
- The mortality rate for NF with medical management alone is 100%; surgical intervention is required for improved outcomes.



necrosectomy, and fasciotomy, is paramount to patient survival.^{1-3,5,10,11} Prompt diagnosis of NF and timely surgical intervention are often impeded by lack of pathognomonic physical examination findings and the time needed to receive biopsy and culture results.

This case series describes the presentation and diagnostic and laboratory findings of NF while emphasizing the need for urgent and aggressive surgical and medical interventions.

HISTORY AND PRESENTATION

All 4 dogs were referred from primary care or specialty

hospitals and had received treatment before arrival at the University of Florida College of Veterinary Medicine (UFCVM). Previous treatment for 3 of the dogs was nonsteroidal anti-inflammatory drugs for 1 to 5 days before presentation, while the other dog had received oral and injectable antibiotics before referral.

Patient signalments, presenting complaints, and affected areas are listed in **TABLE 1**. Of the 4 dogs, 3 had at least 1 swollen limb, of which 2 had multiple affected limbs. Two dogs had ventral truncal edema.

At the time of referral to the UFCVM, 3 dogs were notably dehydrated, were painful, and had altered

TABLE 1 Clinical Features of Necrotizing Fasciitis in 4 Dogs

FEATURE	PATIENT 1	PATIENT 2	PATIENT 3	PATIENT 4
Signalment	3.5-year-old MN mastiff	8-month-old FS mixed-breed dog	4.5-month-old M husky	3.5-year-old F mixed-breed dog
Presenting complaint	Recumbent, swollen right forelimb	Surgical site swelling, discoloration of swelling, lethargy, inappetence	Severe pain, pelvic limb lameness that rapidly progressed to include the forelimbs, non-weight-bearing right forelimb lameness	Lethargy, hematochezia, hematemesis, bruising on ventrum
History of trauma	No	Ovariohysterectomy and hernia repair	No	No
Comorbidities	No	No	No	No
Location	Right thoracic limb, axilla, trunk	Ventral abdomen	Right lateral thorax, thoracic inlet, ventral neck	Ventral thorax, shoulders, forelimb
Description of lesions	Marked pitting edema	1.5-cm surgical incision is clean. Marked bruising on ventral abdomen (worse on the left side)	20×30×2-cm regionally extensive focus of tan to black soft tissue with cavitations	Edematous ventrum, bruising of ventrum extending to include shoulders and forelimbs with some focal areas of firm discoloration
Culture results	<i>Streptococcus canis</i> , <i>Staphylococcus pseudintermedius</i>	<i>Escherichia coli</i>	None	None
NSAID history	Carprofen	Meloxicam, robenacoxib	Carprofen	None
Antibiotic history	- None before arrival at UFCVM - UFCVM: ampicillin/sulbactam, ceftazidime	- None before arrival at UFCVM - UFCVM: ampicillin/sulbactam, ceftazidime, clindamycin	None	- Primary veterinarian: metronidazole - Referral specialty hospital: metronidazole, ampicillin/sulbactam, enrofloxacin - UFCVM: ampicillin/sulbactam, enrofloxacin (discontinued after 1 dose), ceftazidime

F = female; FS = female spayed; M = male; MN = male neutered; NSAID = nonsteroidal anti-inflammatory drug; UFCVM = University of Florida College of Veterinary Medicine



mentation (1 dull, 2 obtunded). The remaining dog had been hospitalized with supportive care at a specialty hospital for 3 days before presentation. At the time of the referral, that dog was euhydrated and exhibited moderate mental depression and generalized weakness. The body temperatures of all 4 dogs ranged from normal to elevated (38.6 °C to 40.3 °C [101.5 °F to 104.6 °F]).

All 4 dogs were tachycardic and had gross limb and/or ventral body wall edema, consistent with the owners' complaints of "swelling." All 4 had gross bruising of the affected area; the lesions on patient 3 were not identified until the husky's thick hair coat was shaved during postmortem examination.

DIAGNOSTIC TEST RESULTS

Blood Work

Serum biochemical and hematologic samples were available for all patients. Three dogs had inflammatory

leukograms, and all 4 exhibited a left shift. Moderate to severe thrombocytopenia was present in 3 of the dogs at the time of presentation. Plasma fibrinogen concentration was reported for 3 dogs, of which 2 had hyperfibrinogenemia consistent with inflammation. The most common biochemical findings, found for 3 dogs, were elevated serum alkaline phosphatase, hyperbilirubinemia, and hyponatremia. Blood lactate concentration was moderately elevated in 2 of the dogs, and clotting times were marginally increased in 3. All 4 dogs were normoglycemic and normotensive at the time of presentation; 1 had received parenteral dextrose supplementation before referral.

Imaging and Cytology

In addition to clinical findings, imaging is a valuable tool for diagnosis of NF. Patient 1 arrived with radiographs taken by the primary veterinarian, which demonstrated linear soft tissue wisps within the subcutaneous space of the right antebrachium (FIGURE 2). Computed tomography later performed at the UFCVM confirmed marked thickening of the subcutaneous tissue and fascial planes by fluid-attenuating material. Blood cultures for patient 1 were positive for *S. canis* and *S. pseudintermedius*, further supporting the clinical diagnosis of NF.

Radiographs for patient 2 demonstrated soft tissue swelling along the left lateral thoracic and abdominal body wall, with subcutaneous gas. Although the swelling was abnormal, the gas was initially attributed to recent abdominal surgery. Ultrasonography revealed thickened subcutaneous tissues with moderate



FIGURE 1. Dogs with cutaneous lesions noted primarily on the trunk.



FIGURE 2. Extremity radiographs from patient 1, illustrating linear soft tissue wisps (arrow) within the subcutaneous space of the right antebrachium and extending up the chest.



Previous studies have reported a mortality rate of 100% for dogs receiving antibiotic therapy in the absence of timely surgical debridement.^{1,4,6}

dissecting anechoic fluid consistent with the working diagnosis of NF (**FIGURE 3**). *E coli* was cultured from the site of the initial abdominal incision (now enlarged, swollen, edematous, and severely bruised).

For patient 3, NF was confirmed at postmortem examination, which revealed necrotizing inflammation within the truncal musculature and fascia, within the subcutaneous tissues along the thorax, and extending up the neck (**FIGURE 4**).

Patient 4 underwent limited imaging; however, cytology of the cutaneous lesion revealed degenerate neutrophils with intracellular coccobacilli, emphasizing clinical suspicion for NF when interpreted with history, clinical signs, and disease progression.

TREATMENTS AND OUTCOMES

One patient was euthanized after initial diagnostic testing, and the other 3 underwent aggressive medical management. All 3 hospitalized dogs initially received IV antibiotics (ampicillin/sulbactam and ceftazidime). One of these dogs also received clindamycin, while another received a single dose of enrofloxacin. None of

these dogs underwent surgical intervention because their advanced stage of disease rapidly progressed during attempts to medically stabilize them. DIC developed in 1 dog, and acute kidney injury developed in another. All 3 hospitalized dogs were euthanized within 2 days; median survival time was 6 days (range 4 to 7 days) from the onset of clinical signs.

DISCUSSION

For all 4 dogs in this case series, clinical suspicion of NF was high and early surgical intervention was not performed. Despite aggressive supportive care and broad-spectrum antimicrobial therapy, NF progressed rapidly, resulting in a poor outcome for all 4 dogs. Previous studies have reported a mortality rate of 100% for dogs receiving antibiotic therapy in the absence of timely surgical debridement.^{1,4,6}

Of the 4 dogs in this case series, 3 had no history of trauma and the fourth had recently undergone surgery. Although surgery provides a break in the skin barrier for the introduction of bacteria, the pathophysiology of NF in the absence of trauma in canids is not reported. We can postulate from the human literature that an unknown factor induces a repair response, resulting in the recruitment of leukocytes, along with activation and multiplication of progenitor cells to the affected site. The activated myogenic progenitor cells and macrophages increase vimentin expression and serve as a ligand for binding transient bacteria trafficked to the site. The bacteria proliferate and release exotoxins. The capillaries become occluded by toxin-induced platelet-leukocyte aggregates and damage the vascular endothelium. That blockade results in fluid leakage,

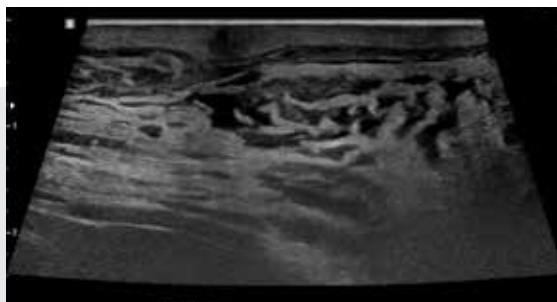


FIGURE 3. Ultrasonography image from patient 2, illustrating the extensive subcutaneous edema, supporting the clinical suspicion of necrotizing fasciitis.



FIGURE 4. Clinical images of patient 3 with rapid, extensive bruising secondary to necrotizing fasciitis.



tissue swelling, erythema, and ischemia of deep soft tissues. As arteries become occluded, the deep tissue necrosis spreads to the upper tissue layers, exhibited as the cutaneous changes described.^{12,13}

The preferred antibiotics are β -lactam and β -lactamase inhibitors; most frequently used are penicillins, carbapenems, and clindamycin.¹⁴ Fluoroquinolones are not recommended due to their limited activity against *Streptococcus* species and the potential for increasing pathogenicity.¹⁵ Supportive care is aimed at treating the patient's systemic status with IV fluid therapy and pain control while closely monitoring vital parameters. Patients that lapse into a hypotensive crisis despite adequate fluid resuscitation may require vasopressors.

The most recent and extensive veterinary study suggests a survivability rate of 80% to 90% for dogs that receive a combination of surgery, antibiotic therapy, and supportive care.¹ The stark contrast in mortality rate with and without surgical intervention is compelling evidence for immediate surgical intervention. Various surgical procedures, including debridement, drain placement, and negative pressure wound therapy, have been described with successful outcomes.^{1-3,5,10,11,16} In humans, mortality increased by 9.4-fold when surgery was delayed for more than 24 hours.¹⁷ Delay between presentation and surgical intervention is extended by awaiting biopsy results, cytology results, or cultures before performing surgery. Postoperative hyperbaric oxygen treatment might be of benefit.¹⁴

Clinicians should recommend immediate surgery based on a high clinical index of suspicion after the patient is hemodynamically stabilized. Clinical suspicion should be raised by pain disproportionate to physical examination findings, swelling/edema, and rapidly advancing diffuse skin bruising with accompanying signs of systemic illness (most commonly fever and tachycardia). To track progression throughout hospitalization, the bruising may be outlined with a permanent marker at the time of admission. Another preoperative examination feature is a positive "finger test." This test is suggestive of NF when a gloved finger is inserted into the affected site and a lack of bleeding and resistance to blunt dissection is observed, often accompanied by a "murky dishwater fluid."¹⁸

Although the current veterinary literature suggests that most NF lesions are on the extremities or neck, in this case series, all 4 dogs had lesions on their trunk.^{1,8} Three dogs had moderate to severe thrombocytopenia

at presentation, most likely resulting from an ongoing consumptive coagulopathy, which further justifies assessing hemostasis during the initial diagnostic and treatment stages of NF, especially because major surgery is anticipated.

The radiographic feature of soft linear wisps in the subcutaneous space should raise concern for NF. Documented in a previous case report, this diagnostic finding is particularly valuable for primary care clinicians who do not have access to other imaging modalities.² Although the linear wisps are not pathognomonic for NF, this finding in the absence of trauma in a patient with evidence of systemic illness should place NF as a differential diagnosis.

The UFCVM operates as a tertiary referral facility, and all 4 dogs in this case series were evaluated and treated at other facilities before arrival. The average duration of clinical signs before presentation was 4.5 days (range 2 to 6 days), which usually leads to a catastrophic ending.

Limitations of this case series included it being retrospective and having a limited number of cases. Future prospective studies with standardized diagnostic, therapeutic, and surgical protocols should aid in developing a scoring system to rapidly identify NF and improve the time between presentation and surgical intervention.

Although we cannot predict favorable outcomes for all dogs with early surgical intervention, we can surmise that delayed surgical intervention significantly contributed to the high mortality rate reported in this case series. Because surgical treatment can be cost-prohibitive for many clients, euthanasia is a suitable option for patients with this highly morbid condition.

SUMMARY

NF is a ravaging disease that rapidly destroys local tissues, earning its moniker "flesh-eating disease." It commonly causes extreme pain disproportionate to the external appearance of associated lesions, swelling or edema, and reddish to black pigmentation of the affected area. These findings, combined with signs of systemic shock, should raise significant clinical suspicion for NF requiring urgent surgical exploration. Referral to surgery before the onset of septic shock will likely improve the prognosis, but failure to do so carries a grave prognosis warranting humane euthanasia. **TVP**



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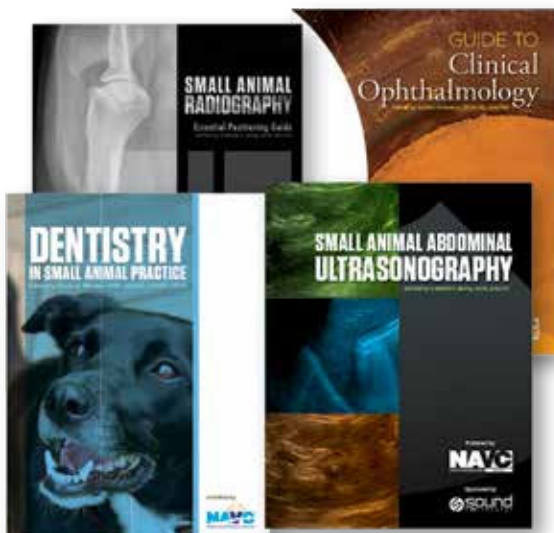


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Dr. Schaer received his DVM degree from the University of Illinois in 1970 and became a diplomate of ACVIM in 1975 after his internship and residency at the Animal Medical Center in New York City. He joined the faculty at the University of Florida College of Veterinary Medicine in 1978, where he remains. He has published numerous papers and book chapters, authored 5 textbooks, and lectured nationally and internationally. Dr. Schaer went on to become a diplomate of ACVECC in 1989. He is currently professor emeritus and adjunct professor in emergency and critical care medicine, while still teaching in the classroom and the critical care unit.

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