Necrotizing fasciitis is an aggressive, invasive soft tissue infection. Because it can rapidly progress to patient instability, prompt diagnosis followed by urgent debridement is critical to decreasing mortality. Despite the importance of early diagnosis, necrotizing fasciitis remains a clinical diagnosis, with little evidence in the literature regarding the effectiveness of diagnostic tools or criteria. Common clinical findings are nonspecific, including pain, blistering, crepitus, and swelling with or without fever and a known infection source.

This article describes a patient who was transferred to the authors’ institution from another hospital, where she had been taken following seizure activity and was treated with antibiotics for suspected cellulitis at the intravenous catheter placement site on her left dorsal hand. On admission to the current authors’ institution, she presented with pain and swelling in the setting of significant left upper-extremity emphysema. She had undergone a left shoulder arthroscopy 4 weeks previously. Vital signs were within normal limits, and a preoperative chest radiograph was read as normal. The patient underwent an emergent fasciotomy, irrigation and debridement of the left upper extremity, and intravenous antibiotics for suspected necrotizing fasciitis. Intraoperative findings indicative of infection were absent, and a left apical pneumothorax was later found on postoperative chest imaging.

In a stable patient with a normal chest radiograph on presentation who demonstrates upper-extremity crepitus suspicious for necrotizing fasciitis, a chest computed tomography scan may be indicated to rule out an intrathoracic source.
Necrotizing fasciitis is a rapidly progressing infection of the fascia and subcutaneous tissue that affects all body parts.\(^1\) It can result from direct transmission through skin violation and breakdown or indirectly through hematogenous spread.\(^2\) Involvement of the upper extremity is relatively rare, representing 6% to 27% of cases reported in the literature.\(^1\) Due to its aggressive nature resulting in the rapid decline of patient stability, early diagnosis and subsequent debridement within 24 hours are at the cornerstone of treatment.\(^3,4\) Delayed or incomplete debridement has increased mortality from 4.2% to 38%.\(^5\) Because it is a rare condition, the literature on necrotizing fasciitis has historically been limited to retrospective studies and case reports, resulting in little evidence supporting diagnostic tools or criteria. Necrotizing fasciitis remains a clinical diagnosis, suspected with severe pain, blistering, crepitus, and swelling in the setting of a fever or known infection source.\(^2\) This article describes a case of massive upper-extremity subcutaneous emphysema from an undiagnosed pneumothorax, which prompted immediate surgical intervention for suspected necrotizing fasciitis.

**Case Report**

An 18-year-old right-hand-dominant woman living in a group home for psychiatric illness was transferred from another hospital with left upper-extremity subcutaneous emphysema. The patient reported 5 days of left upper-extremity pain and swelling that started after the placement of an intravenous line in the dorsum of her left hand for seizure activity. She reported no history of trauma. The patient had been treated for 2 days at another institution for suspected cellulitis at her intravenous catheter insertion site with 1 dose of intravenous antibiotics followed by oral antibiotics with no improvement in her symptoms. She reported no systemic illness, tachypnea, or dyspnea. She reported nausea, vomiting, and a fever of 102°F 1 day prior to admission to the current authors’ institution. The patient had a medical and surgical history significant for psychiatric illness with self-injurious behavior, seizure disorder, and a left shoulder arthroscopy performed for impingement syndrome using scalene regional anesthesia 4 weeks previously.

On presentation, vital signs were within normal limits. The patient was well-appearing and in no apparent distress. Her chest was clear to auscultation bilaterally. The left upper extremity was swollen, with palpable crepitus extending from her left distal digits to the chest wall. A small area of erythema was present over the dorsum of the left hand at the site of her previous intravenous catheter. Well-healed arthroscopy portal incisions were noted about the left shoulder. The patient reported slight pain with active elbow and wrist range of motion. Normal sensation, motor strength, and pulses were present throughout the left upper extremity.

Laboratory examination revealed a white blood cell count of 11.2/mm\(^3\), platelet count of 201,000/µL, and hemoglobin of 12.5 g/dL. A chemistry panel revealed a sodium of 136 mEq/L, creatinine of 0.5 mg/dL, and glucose of 124 mg/dL. Inflammatory laboratory results showed an erythrocyte sedimentation rate of 15 mm/h and a C-reactive protein of 2.1 mg/dL. Gram stains from blood cultures were preliminarily negative. A chest radiograph read by an attending radiologist was negative for pneumothorax or other acute pathology. Radiographs of the left upper extremity were significant for extensive subcutaneous emphysema (Figures 1-4).

The patient was evaluated in the emergency department by an orthopedic trauma surgeon, orthopedic hand surgeon, and general trauma surgeon (C.T.B.). Due to her extensive subcutaneous emphysema without evidence of intrathoracic pathology on physical examination or imaging, the patient emergently underwent incision and debridement for presumed necrotizing fasciitis. Incisions were made on the dorsum of the left hand, the dorsal and volar surfaces of the forearm, and the lateral aspect of the arm. Fascial specimens taken from all 4 sites were sent to the microbiology laboratory. No necrotic tissue, purulence, or foul-smelling odor were noted from any surgical site. The surgical sites were copiously irrigated, packed with damp, sterile gauze, and left open. Postoperatively, the

![Figure 1: Anteroposterior (A) and lateral (B) radiographs of the humerus showing extensive subcutaneous emphysema.](image-url)
patient was managed by the general surgery trauma service, remained intubated for presumed necrotizing fasciitis, and was started on intravenous vancomycin and piperacillin and tazobactam. The patient remained afebrile with normal vital signs and was extubated on postoperative day 1. All fascial specimens were negative for organisms on gram stain and culture. A postoperative chest radiograph showed a left apical pneumothorax. On reevaluation by the attending radiologist, the initial emergency room chest radiograph was determined to reveal a corresponding apical pneumothorax. A postoperative computed tomography scan of the chest showed resolution of the pneumothorax without residual blebs.

**DISCUSSION**

Necrotizing fasciitis is a progressive, inflammatory infection with a mortality rate ranging from 6% to 76%. Time to operative intervention is the most important determinant of mortality. Delays in treatment greater than 24 hours have been associated with a significant increase in mortality, making high clinical suspicion and knowledge of specific signs and symptoms of necrotizing fasciitis critical to achieving optimal outcomes. However, studies have shown that necrotizing fasciitis is initially misdiagnosed in 35% to 86% of cases. Diagnosis requires identifying a rapidly progressive course after damage to the cutaneous tissue, including trauma, minor skin infection, postoperative infection, or injection. Unlike cellulitis, necrotizing fasciitis originates from the deep fascia and subcutaneous fat, making erythema and edema of the more superficial epidermal and dermal skin layers initially absent.

Diagnostic tools, including signs, symptoms, and laboratory studies, have varied in their usefulness. The classic distinguishing symptom is pain out of proportion to physical examination, although some patients experience little to no pain in the setting of necrotizing fasciitis. Crepitus, skin necrosis, or both are found in 13% to 31% of cases. The majority of patients with necrotizing fasciitis exhibit erythema, tenderness, or edema beyond the confines of infection, whereas hypotension, elevated temperature, and mental status changes are usually absent. Although highly specific for necrotizing fasciitis, radiographic evidence of subcutaneous emphysema is commonly delayed or absent.

The role of serum laboratory values in the diagnosis of necrotizing fasciitis remains unclear. In 2000, Wall et al reported that admission laboratory values of...
The exact etiology of the patient’s pneumothorax is unknown. Multiple case reports have reported subcutaneous emphysema of the chest wall and upper extremity secondary to shoulder arthroscopy in the intraoperative or immediate postoperative period. In addition, pneumothorax is a known potential complication after scalene regional anesthesia. Given her psychiatric history, factitious injection of subcutaneous air was also considered in the differential diagnosis because it has been reported in the literature. Although the patient reported no history of trauma, it is possible that she fell during her seizure, causing a traumatic pneumothorax from which air may have propagated distally prior to presentation.

**CONCLUSION**

Multiple diagnostic criteria, including clinical signs and laboratory tests, have been suggested with varying reliability for distinguishing necrotizing fasciitis from other pathologies. Although this patient showed common signs of necrotizing fasciitis, including palpable crepitus, subjective fever, and subcutaneous emphysema on imaging, her relatively normal laboratory values, as demonstrated by a Laboratory Risk Indicator for Necrotizing Fasciitis score of less than 6, were not highly suggestive of infectious pathology. To the authors’ knowledge, this is the only published report of a pneumothorax causing extensive subcutaneous emphysema prompting surgical intervention for necrotizing fasciitis. High clinical suspicion and a low threshold for operative debridement in a patient with suspected necrotizing fasciitis are the hallmarks of minimizing mortality. When a stable patient with suspected necrotizing fasciitis of the upper extremity demonstrates subcutaneous emphysema in the setting of a normal chest radiograph, a chest computed tomography scan may be beneficial for ruling out occult pneumothorax or other intrathoracic pathologies.

**REFERENCES**

14. Holland MJ. Application of the Laboratory Risk Indicator in Necrotising Fasciitis (LRINEC) score to patients in a tropical ter-


