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Delayed Diagnosis of a Fatal Case of *Vibrio vulnificus* Necrotizing Fasciitis and Septic Shock in a 72-Year-Old Man Following a Suspected Fish Spine Puncture Wound of the Right Foot

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Patient: Male, 72-year-old
Final Diagnosis: *Vibrio vulnificus* necrotizing fasciitis and septic shock
Symptoms: Right foot swelling and pain • ecchymosis • blisters • fever • tachypnea
Clinical Procedure: —
Specialty: Critical Care Medicine

Objective: Unusual clinical course

Background: *Vibrio vulnificus* causes rapidly progressive soft-tissue infection and sepsis, with high mortality in immunocompromised individuals, such as those with chronic liver disease. Delayed diagnosis is common when exposure history is inaccurate or concealed. This report describes a fatal case of *V. vulnificus*-induced necrotizing fasciitis and septic shock in a 72-year-old man with chronic alcohol use following a fish spine puncture wound of the right foot, initially diagnosed as snakebite.

Case Report: A 72-year-old man with chronic alcohol use from Liuzhou, China, presented in August 2025 with right foot swelling and pain. On August 7 at 4 PM, he sustained a fish-associated puncture wound from a tilapia fin spine while cleaning fish; the wound was ignored. On August 8, swelling and pain developed, which he misattributed to an animal bite. He was admitted with suspected snakebite (22 h after injury); debridement with vacuum sealing drainage (VSD) was performed. On August 9 (40 h after injury), his condition deteriorated, and the true fish puncture history was obtained. He was transferred to the intensive care unit (ICU); antibiotics were escalated to vancomycin and meropenem. On August 10 (67 h after injury), wound and blood cultures confirmed *V. vulnificus*. Despite maximal support, refractory septic shock and multiple organ dysfunction syndrome (MODS) developed. Treatment was withdrawn, and he died on August 13.

Conclusions: In patients with rapidly progressive limb infection and sepsis following potential fish-related injuries, early clarification of exposure history and timely microbiological evaluation are critical, even when the fish is reportedly from a freshwater source.

Keywords: *Vibrio vulnificus* • Shock, Septic • Bacteremia • Case Reports • Fasciitis, Necrotizing
Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/953950

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Introduction

Vibrio vulnificus is a Gram-negative, halophilic bacterium ubiquitous in warm marine environments [1,2]. This opportunistic pathogen commonly colonizes filter-feeding shellfish, particularly oysters, and has been isolated from various fish and crustacean species [3]. Microscopically, *V. vulnificus* appears as a curved or comma-shaped rod [4].

Once the infection penetrates the skin and reaches the underlying muscle tissues, it can trigger necrotizing fasciitis and necrotizing myositis, ultimately leading to muscle necrosis, septic shock, and multiple organ failure—conditions that are life-threatening [5]. *V. vulnificus* infection is characterized by low incidence but high fatality [3]. Although the infection rate is relatively low, once the disease develops, it progresses rapidly with a high mortality rate. Infection with *V. vulnificus* can rapidly progress to sepsis and necrotizing fasciitis, potentially leading to septic shock and multiple organ dysfunction [6,7]. The mortality rate ranges from 18% to 50%, and death typically occurs within 24 to 48 hours after symptom onset, making *V. vulnificus* the most lethal Vibrio species worldwide [8]. High-incidence regions include subtropical areas such as the U.S. Gulf Coast, Hainan Province in China, and East Asia. In addition, affected by climate warming, higher-latitude regions such as Delaware in the United States and the Baltic and Black Seas have seen emerging cases in recent years and have become new high-risk areas [9]. A meta-analysis and meta-regression revealed that the overall prevalence of *V. vulnificus* in seafood across Asia is 10.47%, with Japan recording the highest rate at 47.6% positive seafood samples [10].

Although *V. vulnificus* is a halophilic bacterium typically associated with marine or brackish-water environments, it has been documented in tilapia from low-salinity aquaculture systems [11] and isolated from market-sold tilapia [12], suggesting that retail-level cross-contamination can also contribute to its presence on freshwater fish. The epidemiological context and mechanism of cross-contamination are further elaborated in the Discussion section below.

This report describes a fatal case of *V. vulnificus*-induced necrotizing fasciitis and septic shock in a 72-year-old man with chronic alcohol use following a fish spine puncture wound of the right foot. This report aims to summarize key diagnostic clues, including exposure history, progressive limb swelling, and sudden onset of severe sepsis, to provide guidance for early identification of marine-derived infections under similar exposure conditions.

Case Report

A 72-year-old man with a long-standing history of chronic alcohol use (approximately 400-600 mL of distilled spirits daily across 3-4 meals) presented to our emergency department on August 8, 2025 (summer). The patient resided in Liuzhou City, Guangxi Province, southern China. Prior to this acute illness, he was functionally independent in activities of daily living, lived alone, and had no reported history of cognitive decline or dementia. However, no formal frailty screening tools were administered at the time of emergency admission.

August 7, 2025, 16: 00 (0 h): He sustained a puncture wound on the medial side of the right dorsum of the foot while cleaning a tilapia at home. The wound produced only minor bleeding and caused no immediate appreciable swelling or pain; consequently, he disregarded it and did not seek any form of wound care.

August 8, 06: 00 (14 h after injury): Progressive swelling and pain developed, the patient suspected a bite to his right foot from an unidentified animal while performing cleaning duties in a flower bed.

August 8, ~ 10: 00 (18 h after injury): He first sought care at a dermatology clinic, where unspecified oral antibiotics, a topical ointment, and antihistamines were prescribed.

August 8, 14: 00 (22 h after injury): After preliminary assessment by the emergency physician, the patient was provisionally diagnosed with "suspected venomous snake bite on the right foot complicated by skin infection" and was subsequently admitted to the emergency department ward for further management.

Admission physical examination is shown in **Table 1**. The patient was alert and oriented, with normal mental status and appropriate responses. He had a supple neck but appeared distressed. Significant swelling was noted in the right foot, accompanied by pain and limited mobility. Two puncture-like wounds approximately 1.5 cm apart could be seen on the back of the right foot, along with a small amount of serous drainage, small areas of bruising, and increased skin temperature. Small, scattered ecchymoses were evident across the skin surrounding the wounds. Movement in the joints of the right foot was noticeably limited by sharp pain.

Laboratory findings on admission showed elevated infection markers (**Table 2**). Other laboratory parameters, including coagulation profile, liver function, renal function, and hepatitis B serology, showed no significant abnormalities.

August 8, 14: 00-17: 00 (22-25 h after injury): Upon admission, the patient received prompt symptomatic treatment consisting of racemic anisodamine hydrochloride to improve microcirculation, calcium gluconate to reduce capillary permeability, intravenous oxacillin for anti–infection, oral diclofenac sodium for analgesia, and omeprazole for gastric mucosal

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Table 1. The patient's vital signs upon admission to the hospital.

Parameter	Value	Reference range
Temperature	36.5 °C	36.1-37.2 °C
Heart rate	92 beats/min	60-100 beats/min
Respiratory rate	21 breaths/min	12-20 breaths/min
Blood pressure	123/78 mm Hg	< 120/80 mm Hg

Table 2. The patient's infection markers upon admission to the hospital.

Parameter	Value	Reference range	Interpretation
WBC	2.72×10^9/L	$4.0\text{-}10.0 \times 10^9$/L	Leukopenia
Neutrophils	2.55×10^9/L	$2.0\text{-}7.5 \times 10^9$/L	Normal
Lymphocytes	0.09×10^9/L	$1.0\text{-}3.5 \times 10^9$/L	Severe lymphopenia
Procalcitonin	262.781 ng/mL	< 0.05 ng/mL	Markedly elevated
IL-6	11.451 ng/mL	< 0.007 ng/mL	Markedly elevated

protection. Subsequently, the patient underwent debridement of the right foot with vacuum sealing drainage (VSD) and remained under close observation.

August 9, 08: 00 (40 h after injury): During rounds, the patient reported increased pain in the right lower extremity. Physical examination revealed ecchymosis, blisters, and dark violaceous discoloration of the right lower extremity (**Figure 1A, 1B**), accompanied by mild abdominal pain, tachypnea, and restlessness. Additional history provided by the family members revealed that the patient had sustained a puncture wound on the medial side of the right dorsum of the foot while cleaning a fish the afternoon before symptom onset. The family identified the fish as tilapia (*Oreochromis* spp.), reportedly purchased from a local wet market in Liuzhou from a freshwater stall directly adjacent to marine seafood vendors, with shared walkways and drainage systems. The patient was barefoot at the time, and the injury occurred when his foot inadvertently contacted the fish. The puncture wound produced only minor bleeding and caused no immediate appreciable swelling or pain; consequently, the patient disregarded it and did not seek any form of wound care. The exact puncturing structure could not be definitively determined; however, based on wound morphology (a single 2-3 mm puncture with no retained foreign body), a dorsal or pectoral fin spine was most likely, though a sharp bony fragment cannot be entirely excluded. The adjacent wet market setting raised the possibility of cross-contamination from marine seafood stalls (see Discussion). No physical specimen of the fish (remains, photographs, or purchase receipts) was available for independent verification.

Based on the patient's history of a freshwater fish puncture injury, followed by swelling, pain, and chills, as well as rapid clinical deterioration leading to septic shock and multiple organ dysfunction, a high suspicion of rare bacterial infections (such as *Aeromonas hydrophila* or *Vibrio species*) was raised.

August 9, 08: 00-12: 00 (40-44 h after injury): Blood cultures were sent. Emergency treatments included: furosemide (20 mg IV) to reduce cardiac preload; fentanyl (continuous infusion) for analgesia; papaverine (30 mg IM) to improve right lower limb circulation, plus vitamin B_1 (IM) for metabolic support; deslanoside (IV) for cardiac support; midazolam (5 mg IV) for sedation during computed tomography angiography (CTA) transport. CTA of the lower extremity, pulmonary, thoracic, and abdominal arteries was performed to exclude vascular compromise, showing aortic atherosclerosis, right lower lobe inflammation, and no significant vascular abnormalities. Norepinephrine infusion via central line to maintain blood pressure. Moxifloxacin + piperacillin-tazobactam + metronidazole for antimicrobial coverage.

August 9, 13: 00 (45 h after injury): The patient was transferred to the intensive care unit (ICU) for further management, where endotracheal intubation with mechanical ventilatory support and hemodialysis were initiated. The antibiotic regimen was escalated to meropenem combined with vancomycin to control the infection. Wound secretion smear and wound secretion culture were sent at ~ 14: 00.

Microbiological Methods and Clinical Management

Aug 10, 11: 00 (67 h): The diagnosis of *V. vulnificus* infection was initially established based on a combination of clinical suspicion, Gram stain findings, culture results, and

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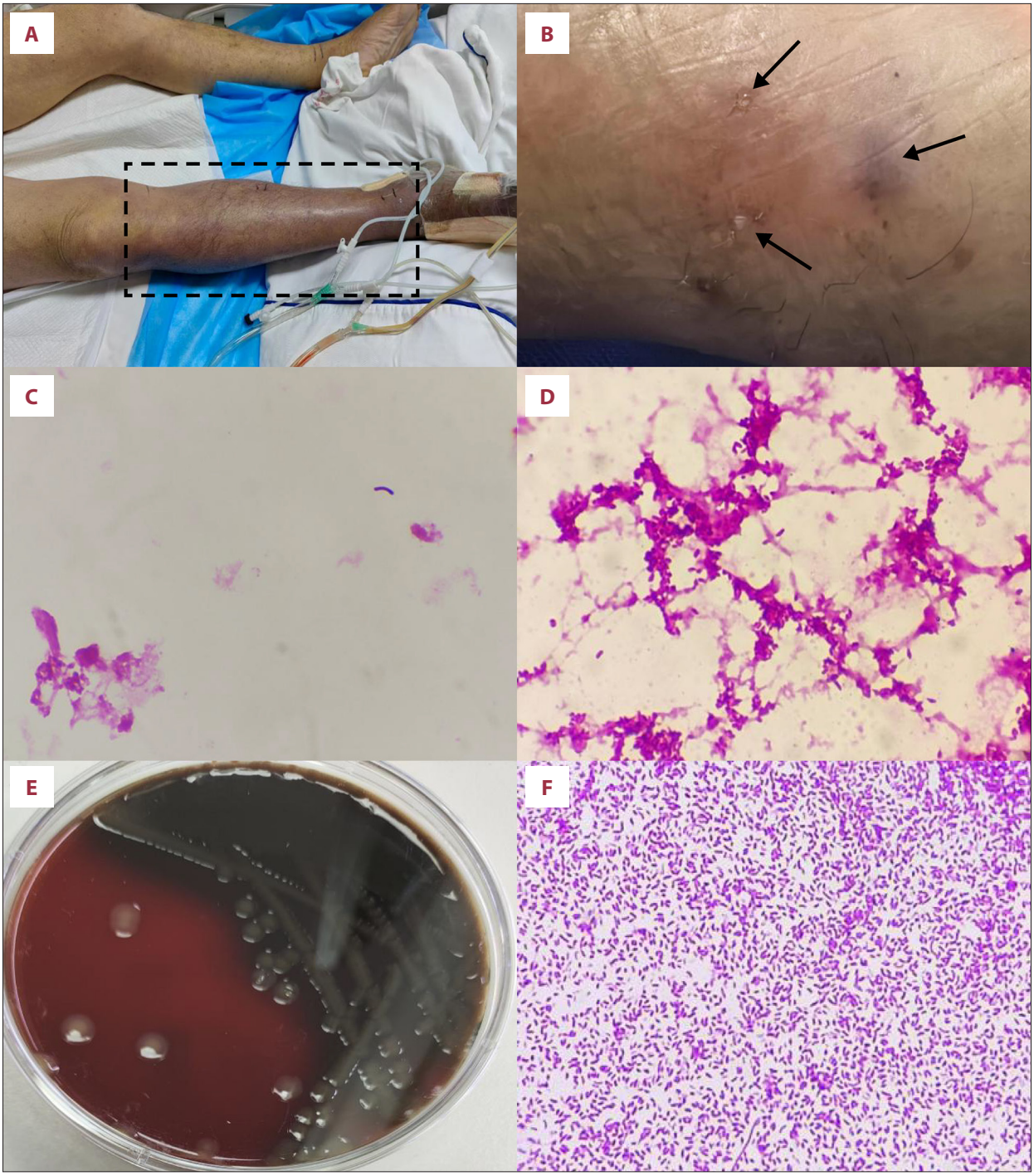


Figure 1. Clinical and microbiological findings of *Vibrio vulnificus* infection. (**A, B**) Clinical photographs of the right lower extremity taken on August 9, 2025 (08: 00), showing extensive ecchymosis, hemorrhagic bullae (arrows), and dark violaceous discoloration (dashed boxes) indicative of progressive soft tissue necrosis and cutaneous ischemia. (**C**) Wound secretion smear showing curved Gram-negative bacilli (Gram stain; oil immersion, 1000 ×). (**D**) Blood culture smear showing curved Gram-negative bacilli, morphologically consistent with panel **C**, obtained from the positive blood culture at 11 hours of incubation (Gram stain; oil immersion, 1000 ×). (**E**) Subculture of positive blood culture on blood agar plate after 24 hours of incubation at 35 °C under CO_2, showing grayish-white, smooth, moist colonies surrounded by clear beta-hemolytic zones (2-3 mm in diameter). (**F**) Gram stain of the colonies confirming curved or short Gram-negative bacilli, arranged dispersedly (oil immersion, 1000 ×).

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Table 3. Antimicrobial susceptibility testing results.

Antimicrobial agent	MIC (mg/L)	Interpretation (S/I/R)
Cefazolin	≥8	R
Cefuroxime	≤8	S
Ceftazidime	≤1	S
Cefotaxime	≤1	S
Cefepime	≤1	S
Ampicillin	≤8	S
Ampicillin-Sulbactam	≤8/4	S
Piperacillin-Tazobactam	≤8/4	S
Gentamicin	≤2	S
Amikacin	≤8	S
Ciprofloxacin	≤0.25	S
Levofloxacin	≤0.5	S
Trimethoprim-Sulfamethoxazole	≤1/19	S
Tetracycline	≤4	S
Azithromycin	≤1	S
Meropenem	≤0.5	S
Cefoxitin	≤8	S

phenotypic identification. Clinical suspicion was raised when the family revealed the true fish puncture history, and the wound secretion smear revealed curved Gram-negative bacilli (**Figure 1C**). Blood cultures signaled positive at 11 hours of incubation, with smear microscopy showing morphologically consistent curved Gram-negative bacilli (**Figure 1D**). Subculture on blood agar yielded grayish-white, beta-hemolytic colonies (**Figure 1E**). Gram staining of the colonies confirmed curved or short Gram-negative bacilli (**Figure 1F**). Species identification was performed using matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry (EXS3000, Zybio, Chongqing, China), which identified the organism as *V. vulnificus*.

Clinical management: Upon ICU admission, antibiotics were escalated to meropenem (1 g IV q8h) + vancomycin (1 g IV q12h), and the patient received continuous norepinephrine infusion, mechanical ventilation, and hemodialysis. Wound care consisted of VSD with regular wound bed assessment; no specific irrigation solutions or dressing change frequency were documented during the ICU stay, and no further surgical debridement was performed due to hemodynamic instability. Despite maximal intensive care support, the patient developed refractory septic shock and progressive multiple organ dysfunction involving the renal, hepatic, and coagulation systems.

Aug 11, 09: 00 (89 h): Antimicrobial susceptibility testing was performed using the TDR-300BPLUS system (TianDiRen, China) and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) M100/M45 guidelines, which showed resistance to cefazolin (MIC ≥8 mg/L) and susceptibility to all other tested agents (see **Table 3** for complete panel). Multiplex PCR-based targeted next-generation sequencing (mp-tNGS) of the blood specimen further confirmed *V. vulnificus*.

Outcome and Follow-up

Aug 11, 16: 00 (96 h): The patient's family withdrew treatment due to the critical condition and lack of curative potential, and the patient was discharged against medical advice. At the time of discharge, the patient was in a deep coma with fixed, dilated pupils (2.0 mm in diameter) and absent light reflexes. Orotracheal intubation was in place with bag-valve ventilation. Extensive blisters were visible on the skin, with purplish discoloration and mottling extending from below the buttocks to the lower limbs and the forearms of both upper limbs, indicating severe circulatory failure.

Aug 13 (~146 h): The patient died at home. The cause of death was presumed to be refractory septic shock complicated by multiple organ dysfunction syndrome (MODS), secondary to *V. vulnificus* bloodstream infection.

The clinical Timeline of Key Events was summarized in **Table 4**.

Discussion

This case demonstrates that *V. vulnificus* infection should be suspected in patients with rapidly progressive skin and soft tissue infections following fish-related injuries, even when the exposure history is atypical and the fish is reportedly from a freshwater source. Early recognition and prompt microbiological evaluation are critical to avoid diagnostic delay.

V. vulnificus primarily infects humans through 2 routes [13,14]. First, the ingestion route involves consuming raw or undercooked contaminated seafood, especially oysters, which may lead to primary sepsis or gastroenteritis. *V. vulnificus* has a high case-fatality rate and can cause life-threatening sepsis. Second,

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Table 4. Clinical timeline of key events.

Date	Time	Elapsed time	Event	Clinical action/status
August 7, 2025	16: 00	0 h	Sustained fish-associated puncture wound on right foot while cleaning fish at home (a dorsal or pectoral fin spine was considered most likely)	Wound ignored; no treatment sought
August 8, 2025	06: 00	14 h	Progressive swelling and pain; misattributed to animal bite	No medical attention
August 8, 2025	~ 10: 00	18 h	Presented to Dermatology outpatient clinic	Unspecified oral antibiotics, topical ointment, antihistamines prescribed
August 8, 2025	14: 00	22 h	Emergency Department evaluation	Admitted with suspected snakebite
August 8, 2025	14: 00-17: 00	22-25 h	Initial treatment; wound debridement with VSD performed	Anisodamine, calcium gluconate, oxacillin, diclofenac, omeprazole
August 9, 2025	08: 00	40 h	Clinical deterioration: ecchymosis, blisters, tachypnea, restlessness; true fish history obtained	Suspected Vibrio or Aeromonas infection
August 9, 2025	08: 10-12: 45	40.2-44.8 h	Supportive measures and diagnostic workup	Furosemide, fentanyl, papaverine, vitamin B_1, deslanoside, CTA (midazolam), central line (norepinephrine); antibiotics escalated to moxifloxacin + piperacillin-tazobactam + metronidazole
August 9, 2025	~ 13: 00-14: 00	45-46 h	ICU transfer; intubation, hemodialysis; antibiotics further escalated	Meropenem + vancomycin; wound cultures sent
August 10, 2025	~ 11: 00	67 h	Microbiological confirmation: wound and blood cultures positive for V. vulnificus; mp-tNGS confirmed	Diagnosis established
August 11, 2025	16: 00	96 h	Refractory septic shock and MODS; family withdrew treatment	Discharged against medical advice
August 13, 2025	——	~ 146 h	The patient died at home	Death

Abbreviations: VSD, vacuum sealing drainage; CTA, computed tomography angiography; ICU, intensive care unit; mp-tNGS, multiplex PCR-based targeted next-generation sequencing; MODS, multiple organ dysfunction syndrome.

the cutaneous route occurs when bacteria enter through wounds exposed to contaminated seawater or seafood, leading to invasive subcutaneous tissue infection or necrotizing fasciitis. Therefore, individuals handling seafood or with seawater-exposed wounds should remain vigilant for progressive skin infections suggestive of *V. vulnificus* necrotizing fasciitis.

Early identification requires understanding key risk factors for severe infection. Predisposing underlying conditions include [7,15]: (1) chronic liver disease (especially cirrhosis or hepatitis)- the strongest risk factor; (2) immunocompromised states (eg, cancer, chemotherapy or immunosuppressive therapy, organ transplant, HIV); (3) other chronic diseases (diabetes mellitus, renal failure, thalassemia, hematologic disorders); (4) advanced age (particularly individuals > 60 years). A meta-analysis of 23 studies with 1892 cases confirmed that liver disease as the strongest independent predictor of mortality in *V. vulnificus* soft tissue infections [16]. In our patient, the only documented predisposing condition was chronic alcohol use; no chronic liver disease, diabetes mellitus, or other immunocompromising condition was diagnosed.

The presence of *V. vulnificus* on a tilapia purchased from a freshwater stall can be explained by 2 mechanisms. First, this organism has been documented in tilapia from low-salinity (< 10%) and brackish-water aquaculture systems [11]. Second, and more

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relevant to this case, retail-level cross-contamination has been documented in wet markets where freshwater and marine seafood stalls share water, ice, cutting surfaces, and drainage systems. Studies have isolated *V. vulnificus* from market-sold tilapia [12], including clinical strains carrying human-associated virulence genes. The stall adjacency in this case makes cross-contamination the most plausible explanation for the presence of this halophilic pathogen on a freshwater fish. This pattern parallels an outbreak in Israel, where tilapia from freshwater ponds caused *V. vulnificus* infections linked to retail handling [17].

This case illustrates a typical clinical diagnostic challenge: although the patient had a history of fish puncture injury, the wound was trivial and the exposure context was inconspicuous, without a typical explicit marine exposure profile. Furthermore, the clinical presentation—including local swelling, pain, and cutaneous ecchymosis—was highly similar to that of a venomous snakebite, which contributed to the delayed diagnosis. However, clinical experience with cryptic infections presenting atypically (eg, mimicking insect or snakebites) remains limited—a knowledge gap addressed by this case. Hu et al reported a case of finger necrotizing fasciitis and septicemia due to *V. vulnificus* following a freshwater fish spine injury in an 86-year-old man without seawater or seafood exposure [18]. Together with our case (the patient sustained a fish puncture injury while cleaning fish at home, initially misattributed to an animal bite), these 2 cases collectively highlight that even without a typical marine exposure history, clinicians should remain highly suspicious of *V. vulnificus* and related marine pathogens, especially in patients with rapidly progressive infection and high-risk factors such as chronic liver disease.

Current guidelines recommend doxycycline plus a third-generation cephalosporin (eg, ceftazidime) or a fluoroquinolone-based regimen as first-line therapy for severe *V. vulnificus* infections [19]. In our patient, initial empirical oxacillin provided no *Vibrio* coverage; after ICU admission, the regimen was escalated to meropenem + vancomycin. Although meropenem has activity against *V. vulnificus*, this carbapenem-based regimen lacked doxycycline or a fluoroquinolone—a deviation from guideline-recommended therapy. However, given the descriptive nature of this single case and the patient's delayed diagnosis and advanced septic shock at ICU admission, no causal inference can be drawn regarding the contribution of any specific antimicrobial choice to the outcome. This case underscores that both antimicrobial selection and timing are important considerations. For patients with suspected *V. vulnificus* infection based on exposure history and Gram stain findings, clinicians should initiate guideline-directed antibiotics without waiting for culture confirmation, while ensuring prompt surgical debridement.

Similarly, several published case reports have described comparable presentations of *V. vulnificus* infection. Wang et al reported a 70-year-old diabetic patient who developed septic shock and necrotizing fasciitis after ingesting raw seafood; NGS confirmed the diagnosis on day 6, but surgical debridement was delayed until day 9, contributing to an unfavorable outcome [6]. This parallels our case in rapid progression to septic shock, diagnostic challenge, and the critical role of timely surgery. Bhat et al described a fatal case of *V. vulnificus* necrotizing fasciitis in a patient with documented alcoholic liver disease and diabetes, highlighting that low clinical suspicion leads to delayed treatment and mortality [20]. In contrast, our patient had chronic alcohol use without a documented diagnosis of chronic liver disease or diabetes, and an inconspicuous exposure history contributed to diagnostic delay. Together, these cases reinforce that *V. vulnificus* should be suspected in rapidly progressive soft tissue infections even without classic marine exposure. In all cases, broad-spectrum antibiotics and surgical debridement were administered, but delayed targeted therapy contributed to unfavorable outcomes.

Despite the absence of technological innovation or identification of a rare emerging pathogen, the clinical value of this case lies in reinforcing key diagnostic and management principles. In rapidly progressive soft tissue infections, even trivial wounds necessitate active investigation of occult exposure histories, with particular heightened vigilance reserved for high-risk individuals with chronic liver disease. Furthermore, in cases of unexplained fulminant soft tissue infection, clinicians should eschew subjective diagnostic assumptions and pursue prompt microbiological evaluation—including wound culture, blood culture, and, when available, mp-tNGS— to reduce diagnosis and treatment delays. This report provides a descriptive account of diagnostic delay and its consequences.

The authors do not make any causal inference regarding the prognostic benefits of any intervention measures, because the patient did not receive timely targeted antimicrobial therapy and his condition progressively deteriorated from presentation to death. This observation is intended to enhance diagnostic awareness, rather than to establish a causal relationship between any particular intervention and patient survival.

Conclusions

We report a case of fatal *V. vulnificus* sepsis and necrotizing fasciitis in a 72-year-old man with chronic alcohol use, initially diagnosed as snakebite due to similar cutaneous findings following a fish spine puncture. In patients with rapidly progressive limb infection and sepsis following potential seafood or fish-related injuries, early clarification of exposure history and timely microbiological evaluation are critical to avoid anchoring bias and treatment delay. The proximity of the freshwater fish stall to marine seafood vendors raised the possibility of

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retail cross-contamination, though this remains speculative as the fish source was not independently verified.

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During the preparation of this manuscript, the authors used DeepSeek, an AI-based large language model, for the purpose of translating the original Chinese draft into English and assisting with language polishing. The AI tool was not used to generate scientific content, analyze data, or formulate conclusions. All clinical data, interpretations, and conclusions presented in this manuscript were conceived, verified, and approved by the authors, who take full responsibility for the accuracy, integrity, and originality of the work.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Department and Institution Where Work Was Done

Department of Emergency Medicine, and subsequently Department of Critical Care Medicine, Liuzhou Traditional Chinese Medical Hospital, Liuzhou, Guangxi, PR China.

Informed Consent

Written informed consent for publication of this case report was obtained from the patient's next of kin prior to manuscript preparation. All patient identifiers have been removed to ensure confidentiality and privacy protection in accordance with the Declaration of Helsinki.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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