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CASE REPORT

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Early diagnosis and application of hemopurification combined with antibiotic therapy and surgical debridement for successful treatment of a child with *Vibrio vulnificus* necrotizing fasciitis and septic shock: a case report

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Abstract

Background *Vibrio vulnificus (V. vulnificus)* is a halophilic marine Gram-negative bacterium. Necrotizing fasciitis caused by *V. vulnificus* is a rapidly progressing clinical emergency often accompanied by septic shock. Despite advances in antibiotics and infection control measures, it remains a highly fatal and disabling infection. The incidence of *V. vulnificus* infection has increased due to climate warming and expanded global seafood trade in recent years. However, pediatric cases of *V. vulnificus* infection remain rare, leading to limited clinical experience in their management.

Methods This report analyzes the clinical data of a pediatric case of *V. vulnificus* necrotizing fasciitis with septic shock, treated at Zhuhai Center for Maternal and Child Health Care in April 2024. The report also reviews the literature on pediatric *V. vulnificus* infection.

Results A 26-month-old boy developed a *V. vulnificus* infection after being scratched by a sea bass. The patient experienced an acute onset of illness that quickly worsened, presenting with a fever, mental fatigue, soft tissue edema, and pain, necrosis of the fascia and foot, coagulation dysfunction, and even shock. Laboratory results revealed white blood cell count(5.0×10^9/L), neutrophilia %(65%), thrombocytopenia (56×10^9/L), elevated CRP (200 mg/L), PCT (67.4 ng/mL), and IL-6 (> 4000 pg/mL), hypoalbuminemia (17.4 g/L), prolonged PT (17.5 s), reduced total T and NK cell counts, and a significantly reduced proportion of Treg cells. Initial treatment included surgical debridement and drainage, empirical antibiotic therapy, and rapid diagnosis of *V. vulnificus via* bacterial wound culture. Next-generation sequencing (NGS) of the blood microbial macrogenome and high-throughput sequencing of wound microbial

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pathogens (MetCap) were performed. Antibiotics were selected based on drug sensitivity testing, accompanied by hemopurification and measures to prevent disseminated intravascular coagulation. The patient's condition stabilized gradually post-treatment, and he was discharged.

Conclusion Prompt diagnosis is important for children with seafood exposure. Early hemopurification, surgical intervention, effective antibiotic therapy, and DIC prevention significantly improve prognosis and survival rates. These findings provide a practical reference for managing pediatric *V. vulnificus* infections.

Highlights

- *V.vulnificus* infection rarely occurs in children;
- Immune immaturity of pediatric patients helps the rapid progression of *V.vulnificus* infections;
- PCR can be used for early detection of *V. vulnificus* besides bacterial culture;
- Cephalosporin III + tetracycline is the preferred drug regimen for early antimicrobial therapy in children;
- Early hemopurification, along with surgical intervention and antibiotic therapy, is essential to treat severe *V. vulnificus* septicemia.

Keywords *Vibrio vulnificus*, Septic shock, Necrotizing fasciitis, Hemopurification, Children

Introduction

Vibrio vulnificus(V. vulnificus) is a Gram-negative, thermophilic, and halophilic bacterium found in warm marine environments, where it grows under both aerobic and anaerobic conditions. It is commonly found in seawater, sediments, and marine organisms in harbors, gulfs, river-sea interfaces, and inland saline lagoons (e.g., oysters, crabs, clams, shrimps, mussels, mullet, and seabass) [1]. *V. vulnificus* is a pathogenic bacterium that infects humans through the consumption of contaminated seafood or contact of wounds with seawater. The disease is primarily manifested in three clinical forms, namely, primary sepsis (43.1%), traumatic infections (45.9%), and gastroenteritis (5%). Reportedly, patients with severe sepsis have a high mortality rate, exceeding 50% in most cases. Moreover, severe wound infections often manifest as necrotizing fasciitis and gangrene, which are associated with high mortality and disability rates [2]. However, pediatric cases of *V. vulnificus*-caused wound infection are rarely reported. This report presents a case of necrotizing fasciitis accompanied by septic shock caused by *V. vulnificus* infection in a 26-month-old toddler who was successfully treated in a hospital in Zhuhai, a coastal city in southern Guangdong province, China.

Case presentation

A 26-month-old boy with no underlying disease was injured on his right heel by a sea bass while playing in a seafood market one afternoon. By midnight, he developed a high fever (39.2 °C) and experienced frequent vomiting. By the next morning, redness, edema, and petechiae appeared around the lesion on his right lower limb, markedly restricting his movement. The emergency department of another hospital examined the boy and found abnormally high levels of C-reactive protein (CRP) and procalcitonin (PCT). Accordingly, a cefoperazone–sulbactam intravenous (IV) drip was arranged. Despite this antibiotic therapy, the patient experienced a high fever, mental deterioration, progressive edema, pain in the right lower limb, and rapidly progressing and expanding petechiae and ecchymosis, prompting his transfer to the pediatric intensive care unit (PICU) of our hospital.

On admission, the patient presented with a temperature of 37 °C, pulse of 151/min, respiration of 35/min, and blood pressure of 96/62 mmHg. Physical examination revealed mental deterioration, right calf edema with petechiae and ecchymoses, a swollen dorsum of the foot with an unpalpable dorsal artery, increased skin turgor, and localized tenderness. Further findings included hypothermic, greenish-black toes, bruised skin, and a capillary refill time of 5 s. Initial laboratory tests revealed the following: white blood cell (WBC) count of 5.0×10^9/L, neutrophil percentage (NE%) of 65%, hemoglobin (Hb) of 120 g/L, platelet (PLT) count of 56×10^9/L, CRP of 200 mg/L, PCT of 67.4 ng/mL, interleukin-6 (IL-6) > 4000 pg/mL, albumin (ALB) of 17.4 g/L, and prothrombin time (PT) of 17.5 s. The absolute counts of total T and natural killer (NK) cells were decreased, and the proportion of regulatory T (Treg) cells was significantly reduced. Blood cultures and drug sensitivity tests were performed immediately. However, no abnormality was found in liver function, renal function, cardiac kinase, infection pathogen groups A + B, urine, and stool examination. A chest X-ray did not present any abnormality either. After admission, the patient's blood reports, CRP, PCT, IL-6, coagulation function, and ALB levels were monitored dynamically. Figure 1 shows the trend graph.

Furthermore, an orthopedic consultation was arranged on the day of admission due to aggravating edema, pain, and spreading ecchymosis in the right lower limb. Eventually, the patient was diagnosed with necrotizing fasciitis, osteofascial compartment syndrome (right foot and right calf), septic shock, and coagulopathy. Accordingly, the initial antibiotic therapy comprised intravenous

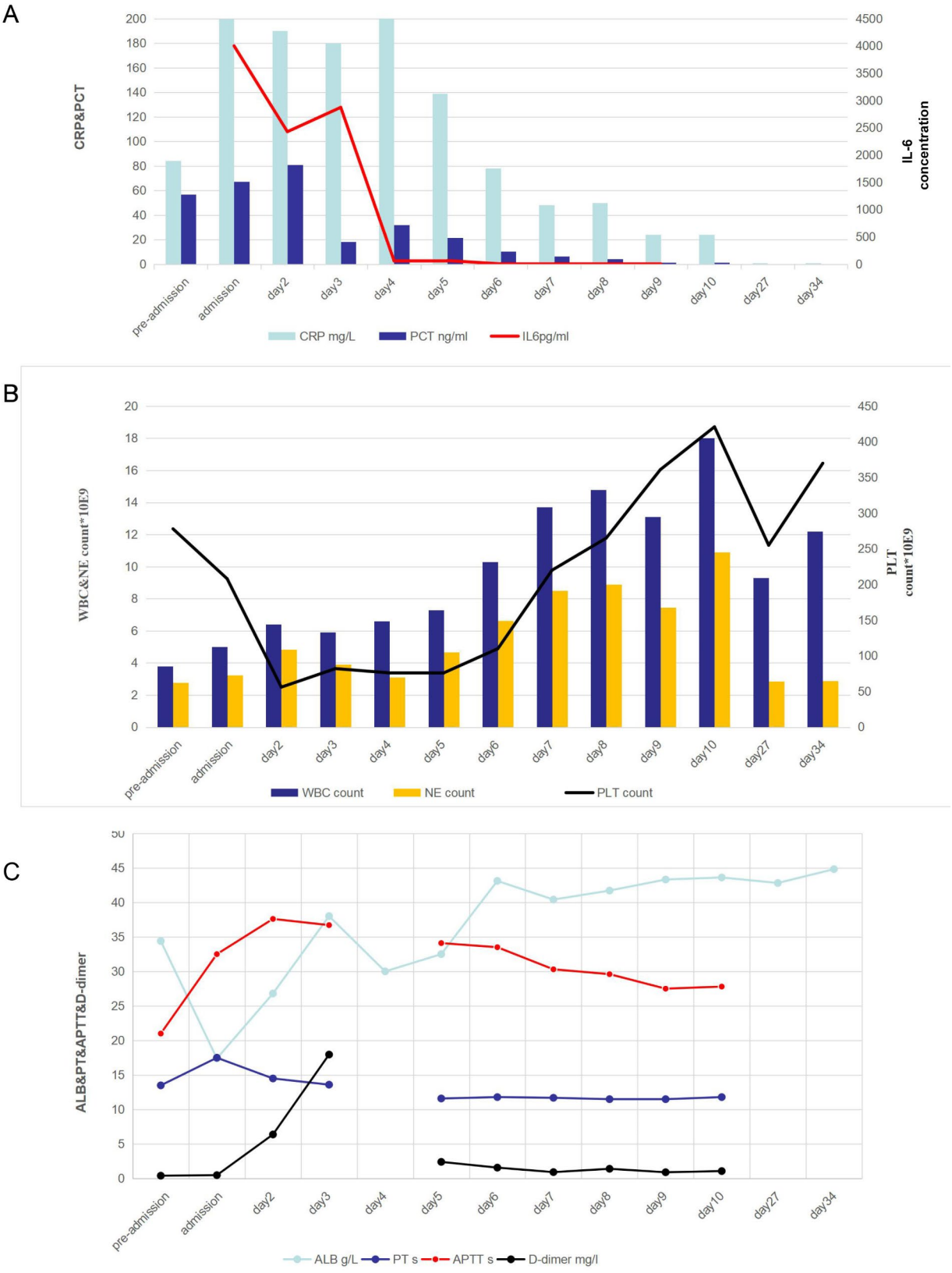


Fig. 1 Dynamic detection of laboratory results during hospitalization. (**A**) CRP, PCT, and IL-6 concentration. (**B**) Absolute values of WBC, NE, and PLT. (**C**) ALB, PT, APTT, and D-dimer test results

administration of meropenem + vancomycin. Moreover, open decompression of the right foot and right calf compartment was performed, and radical debridement was done on all necrotic tissues. However, the patient's condition worsened rapidly intraoperatively, and hemodynamic instability and poor oxygenation were monitored. Thus, fluid resuscitation, vasoactive agent therapy, anticoagulant therapy, and ventilator-assisted respiratory support were provided.

On Day 2, the patient still had a recurrent fever, abundant exudates from the postoperative incision in the right lower limb, enlarged and deepened local skin ecchymosis, and redness and edema spread to the thigh. Meanwhile, wound secretions and blood were cultured. While awaiting the results of pathogen cultures, the patient remained in critical condition due to uncontrolled infection despite prior antibiotic therapy. Similarly, metagenomic analysis of pathogens in blood samples was performed using pathogen metagenomic next-generation sequencing (mNGS) detection, and pathogen high-throughput sequencing (MetCap) was used in wound secretions. Besides, the incision tissue specimen was pathologically tested to ascertain the tissue activity. *Based on clinical findings, V.vulnificus infection was suspected* with a RiCH score of 2 according to the "*V. vulnificus* Sepsis Diagnosis and Treatment Protocol (2018)." A multidisciplinary team consultation was conducted. The treatment plan included initiating intravenous doxycycline, continuing meropenem and vancomycin, and starting hemopurification therapy to remove inflammatory mediators. Hemopurification treatment was performed using Fresen machine, AV600s dialysis membrane (Fresenius, German) for bedside continuous venous-venous haemodialysis filtration (CVVHDF) combined with cytokine adsorbent column CA130 (JaFron, China) for hemoperfusion (HP), replacement fluid flow rate of 0.6–1 L/h, dialysate flow rate of 0.6 L/h, with 4% sodium citrate anticoagulation, treatment duration of 9 h/d.

On Day 3, the patient remained febrile, with local bloody maculopapular lesions on the right calf and dorsal periphery of the foot, local tissue necrosis at the incision, greyish-purple plantar tension on the right foot, and blackish-purple skin on the distal joints of 2–4 toes. Bacterial cultures of wound secretions (Fig. 2A), MetCap of wound secretions, and NGS of the blood established *V. vulnificus* infection. Subsequent drug susceptibility testing indicated that the bacteria were susceptible to ceftazidime, cefoperazone–sulbactam, tigecycline, and levofloxacin (Fig. 2B). Further, incision histopathology indicated acute suppurative inflammation with necrotic variations (Figure 3C). Antibiotic therapy was revised immediately based on the "*V. vulnificus* Sepsis Diagnosis and Treatment Protocol (2018)" and drug sensitivity results. Intravenous ceftazidime (50 mg/kg, q8h*10 day) and doxycycline (2 mg/kg, q12h*10 day) were initiated, while vancomycin and meropenem were discontinued. Hemopurification therapy was continued using HP and CVVHDF(the details are the same as the Day2), to remove inflammatory mediators. Radical debridement and plantar decompression of necrotic skin and subcutaneous tissues were performed, followed by daily debridement, dressing changes, and multiple incisions for decompression and drainage of skin blisters on the right lower limb. During this period, transfusions of fresh frozen plasma, fibrinogen, platelets, and prothrombin complex were administered to manage disseminated intravascular coagulation (DIC).

By Day 9, the patient's condition stabilized in the PICU, systemic toxic symptoms subsided, and infection and inflammatory markers normalized (Fig. 1A). Besides, the patient underwent enlarged debridement and continuous negative-pressure wound therapy, including Vacuum Sealing Drainage (VSD).

On Day 10, the patient was transferred to the orthopedic ward to continue the antibiotic therapy, and amputation of the gangrenous 2nd-5th toe (Day27 and Day 34) and skin grafting(Day 50) were performed at subsequent times. Finally, the patient was discharged with good postoperative recovery(Day 60). Table 1; Fig. 3 show the clinical course during the acute phase in our patient, while Supplementary Tables S1 and Supplementary Fig. S2 show that during the subacute phase. Figure 2D shows temperature fluctuations during the 10 days after admission.

Discussion

The incidence of *V. vulnificus* infection has increased, attributed to environmental and human factors such as climate change and seafood handling practices [10–13]. Prevention efforts for *V. vulnificus* infections have largely focused on oyster consumption, leading to a decline in vibriosis associated with raw oysters but an increase in wound infections. Wound infections in high-risk individuals may spread rapidly, developing into severe myositis and necrotizing fasciitis, also progressing to secondary sepsis, even life-threatening [14, 15]. The patient was infected by a perch abrasion on the root of the right foot, which manifested as necrosis of the skin and fascia of the tissues. The infection had an acute onset, rapidly advancing to septic shock.

V. vulnificus sepsis is recurrent and reported globally, with a more distinct regional and seasonal pattern. The disease onset is typically between March and November, particularly in summer when the sea surface water temperature is 23–29 °C [16]. In China, V. vulnificus infections are mainly found in the southeastern coastal regions of Taiwan, Fujian, and Guangdong. Of note, patients with chronic liver disease, long-term alcoholism, hereditary

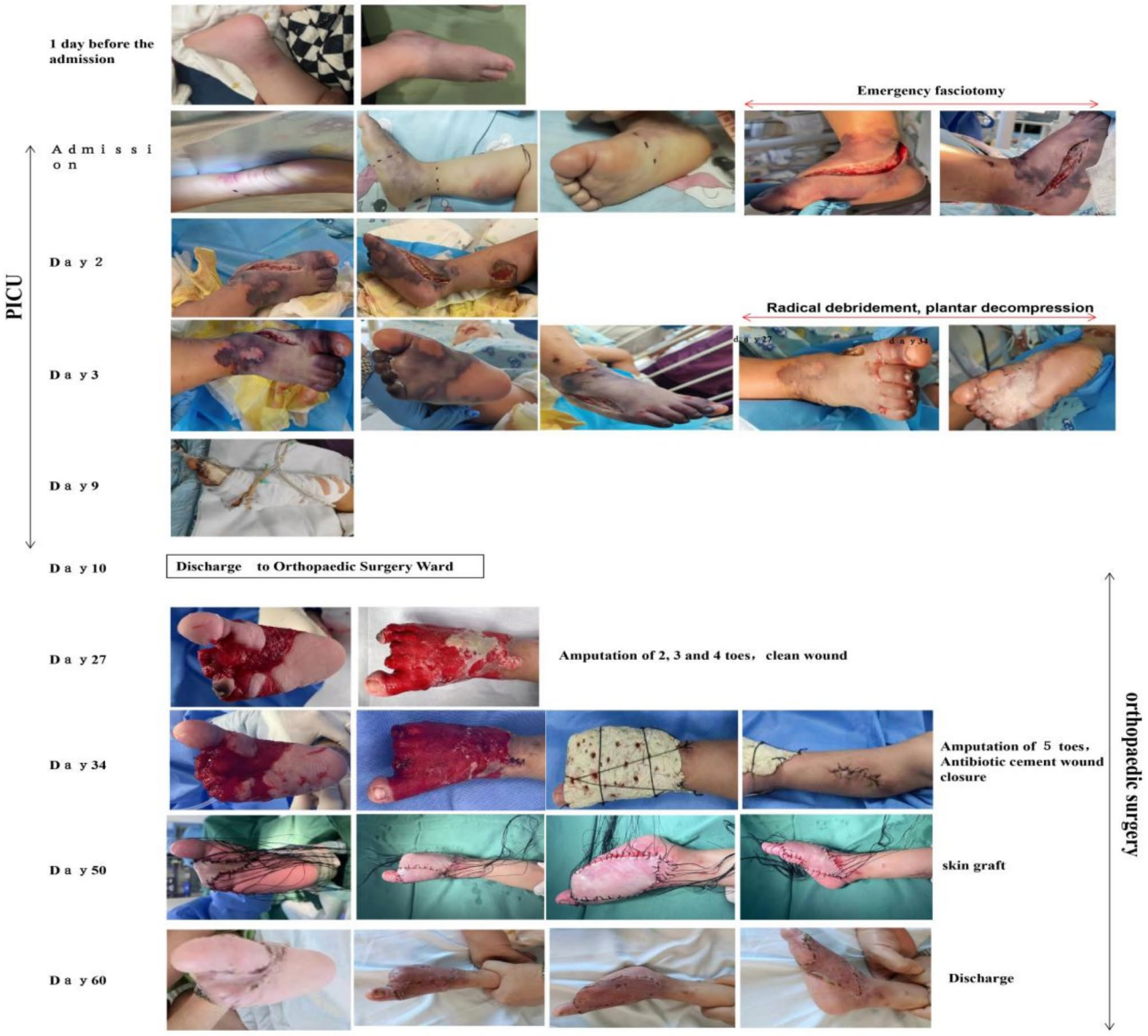


Fig. 2 Summary of the clinical course during the acute phase in our patient

hemochromatosis, and immunocompromised patients are more prone to *V. vulnificus* infection. Indeed, the mortality rate is significantly higher in immunocompromised patients [17], with males outnumbering females (male: female ratio, 3:1–8:1). Our patient aligned with the population attributes, regional and seasonal pattern of *V. vulnificus* infection.

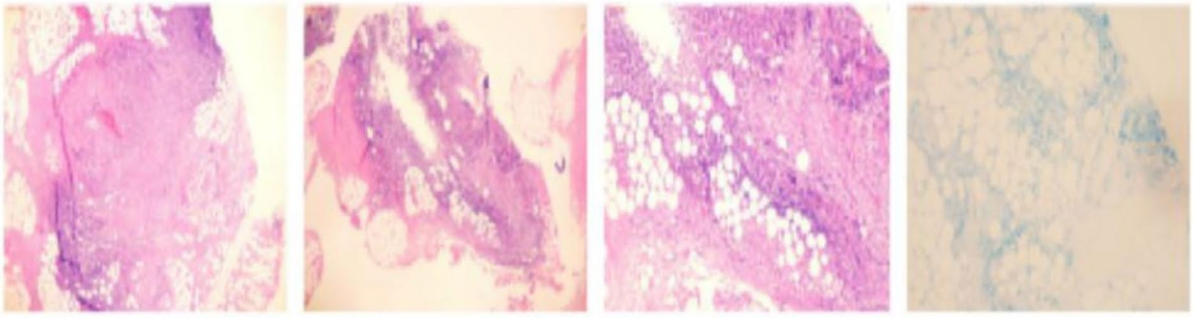
As *V. vulnificus* infection is rare in children, PubMed and the China Knowledge Initiative were searched using the keywords "*V. vulnificus* & children" to search currently reported cases of infection. To date, 10 pediatric cases of *V. vulnificus* infection have been reported, including ours. All but 2 patients had a history of exposure, including consumption of undercooked seafood, contact with seawater, or direct invasion through wounds, which 60% of cases presented as invasive tissue necrosis, and developed septic shock within 48 h, with a male: female ratio of about 8:1 [18]. Only four of these cases involved underlying conditions, including nephritic syndrome, thalassemia major, and Diamond–Blackfan syndrome, and 1 patient with nephritic syndrome died [3–9]. Thus, as one of the high-risk groups for infection, children with immature immune systems are usually susceptible to *Vibrio*, which is the leading cause of wound infections that can spread quickly and progress into severe myositis and necrotizing fasciitis, often accompanied by septic shock, or might even be fatal. Hence, clinicians should focus on the risk of *V. vulnificus*-related disease caused by wound infections in high-risk children.

A

B

Type name	Result	
Culture result	Vibrio vulnificus	
Resulbacterial culture	Vibrio vulnificus	
Tigecycline	<=0.5	Sensitivities
Imipenem	<=0.25	Sensitivities
cefuroxime	4.0	Sensitivities
Amoxicillin/CA	<=2.0	Sensitivities
cefoxitin	32.0	Resistant
Trimethoprim/sulfa	<=20.0	Sensitivities
Levofloxaci	<=0.12	Sensitivities
Cefotaxime	<=0.12	Sensitivities
Ceperazon/Sulbactam	<=8.0	Sensitivities
Amikacin	4.0	Sensitivities

C



D

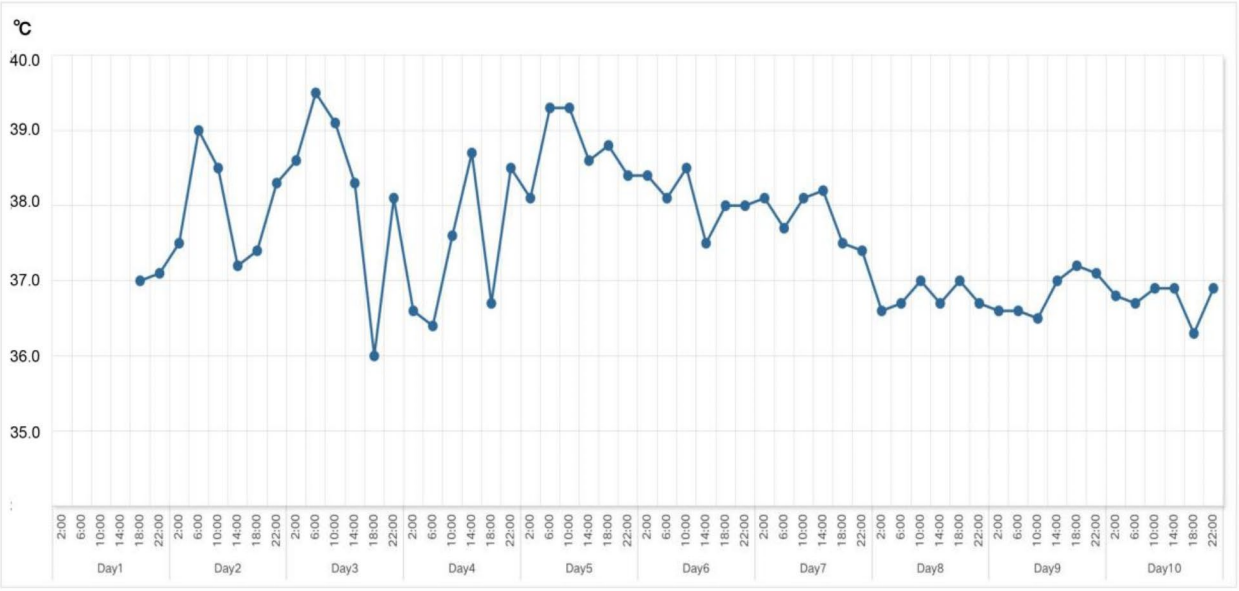


Fig. 3 Experimental findings and body temperature trend related to *V.vulnificus* infection. (**A**) Colony growth in the blood AGAR plate(arrows point to *V.vulnificus* colonies). (**B**) Results of the *V.vulnificus* drug sensitivity test, and *V.vulnificus* colonies was sensitive to Tigecycline, Imipenem, cefuroxime, Amoxicillin/CA, Trimethoprim/sulfa, Levofloxac, Cefotaxime, Ceperazon/Sulbactam, Amikacin, while resistant to cefoxitin. (**C**) Graphic diagnostic reports of pathological tissue sections(Right foot medial-lateral incision tissue). The tissue sent for examination shows acute suppurative inflammation with necrotic changes. Special stains: PAS Beam (-), Anti Acid Stain (-). (**D**) Body temperature fluctuations over 10 days post-admission

V. vulnificus infection can be suspected based on clinical and epidemiological results established by bacteriological cultures [19]. Blood and skin lesion cultures are essential for diagnosing *V. vulnificus* septicemia. However, as *V. vulnificus* is highly sensitive to antibiotics, culture tests in patients with suspected *V. vulnificus* sepsis after administering antibiotics cannot dismiss the likelihood of *V. vulnificus* sepsis even if it is not detected [20, 21]. In addition, microbiological cultures have a high specificity but take longer to establish diagnosis. Despite prior antibiotic therapy and negative post-admission blood cultures, *V. vulnificus* infection was confirmed through MetCap of wound secretions and mNGS of blood specimens, demonstrating the utility of polymerase

Table 1 Summary of the clinical course during the acute phase in our patient

	Condition	Important laboratory results	Important therapeutic measures			
			Antibiotics	Surgery	Hemopurification	Other
1 day before admission (afternoon)	fisher exposure	-	-	-	-	-
1 day before admission (midnight), other hospital	fever (39.2℃) vomiting lower limbs painful swelling	WBC 3.8*10^9/L PCT 56.7ng/dl CRP 86.2 mg/L	Cefoperazone sulbactam	-	-	-
Admission (PICU)	Symptoms progression with shock	PCT 67.4ng/dl CRP 200 mg/L IL6>4000pg/ml PT 17.5s	Meropenem+ Vancomycin	Emergency fasciotomy	-	Antishock Ventilator-assisted Anticoagulant
Day2	General deterioration Erythema spreading to the thighs	PCT 81ng/dl CRP>190 mg/L IL6 2427pg/ml	Meropenem+ Vancomycin +doxycycline	-	CVVHDF + HP	Ventilator-assisted
Day3	Haematological macu lopapular lesions Wound tissue necrosis	PCT 18.1ng/dl CRP>180 mg/L IL6 2873pg/ml		Radical debridement plantar decompression	CVVHDF + HP	Anticoagulant
	Plantar hypertonia	Cultured&PCR: ***V. vulnificus***	**Oxycycline+ ceftazidime**			
Day9	Systemic symptoms of toxicity subsided	CRP 16 mg/L		Debridement VSD diversion	-	-
Day10 (Discharge to Orthopaedic)	Gradual recovery In stable condition	-		-	-	-

Note: *Vibrio vulnificus (V. vulnificus)*, C-reactive protein (CRP), procalcitonin (PCT), pediatric intensive care unit (PICU), white blood cell (WBC), neutrophil percentage (NE), interleukin(IL), prothrombin time (PT), Polymerase chain reaction(PCR), Vacuum Sealing Drainage(VSD), hemoperfusion (HP), continuous venous-venous haemodialysis filtration (CVVHDF)

chain reaction (PCR) in the early diagnosis of *V. vulnificus* infections in children, even in those who have been treated with antibiotics previously.

Laboratory tests play a vital role in clinical judgment of the disease severity and in guiding its treatment and prognosis. A study reported that more than half of the patients with *Vibrio* infections died when PCT > 20 ng/mL [22]. Thus, higher PCT is an independent risk factor for death due to *Vibrio* infection [22]. Of note, thrombocytopenia, Hb reduction, significantly prolonged PT, higher CRP levels, and severe hypoalbuminemia correlate with mortality in patients with *Vibrio* infection. Furthermore, dysfunction of NE, monocytes, and lymphocytes might exacerbate the risk of certain life-threatening infections related to *V. vulnificus* [23–25]. Importantly, *V. vulnificus* infection stimulates the host to produce multiple proinflammatory cytokines, including the overproduction and dysregulation of tumor necrosis factor -α, IL-6, and other inflammatory mediators, and displays severe inflammatory responses characterized by the upregulation of proinflammatory cytokines [26], which is critical in *V. vulnificus*-related septic shock, and results in high mortality [26–30]. In this case, *t*hese laboratory findings characteristics were observed on admission(Fig. 1A-C). Overall, our patient's infection was extremely severe, with a very high risk of death and challenging treatment [22].

Timely and effective antibiotic anti-infection combined with surgical intervention is the key to conventional treatment of *V. vulnificus* infections [22, 31]. Both in vitro and in vivo studies have demonstrated that *V. vulnificus* is susceptible to almost all commonly used antibiotics, and cephalosporin III + tetracycline is the recommended initial antibiotic regimen for *V. vulnificus* infection. Other studies have reported that certain advanced fluoroquinolones could be used as alternatives. Reportedly, treatment of severe wound infections includes doxycycline/quinolones + cephalosporin III, as well as aggressive surgical treatment [32].

Of the 9 children with *V. vulnificus* infections reported, 6 received definitive antibiotic therapy, all with cephalosporins III or IV in combination with tetracyclines or aminoglycosides, and 4 received surgical treatment and skin grafting [3–9]. Our patient's infection demonstrated in vitro sensitivity to tetracyclines, cephalosporin III, and quinolones (Fig. 2B). Tetracycline causes teeth staining in young children and is relatively milder than quinolones in causing side effects. Following early surgical debridement and fascial decompression, and pathogen identification within 72 h, the patient was treated with targeted antibiotics (Ceftazidine combined with doxycycline)

to eliminate the lesion and rapidly control the infection, as indicated by significant reductions in CRP and PCT levels(Fig. 1A). Subsequent treatment included toe amputation and skin grafting. The patient was ultimately discharged in good condition. This case highlights the importance of early surgical intervention combined with effective antibiotic therapy in managing *V. vulnificus* infections in children, with cephalosporin III and tetracycline as the preferred initial regimen for pediatric patients.

Hemopurification has shown promise in severe *V. vulnificus* infections by removing inflammatory mediators through circulatory convection and adsorption. Feng et al. [33] demonstrated the effectiveness of hemopurification in pediatric septic shock, including stabilization of blood pressure, enhancement of tissue perfusion, and elimination of inflammatory mediators. Continuous renal replacement therapy (CRRT) is also employed to modulate immune responses in sepsis [34]. Four cases of *V. vulnificus* peritonitis have been reported in patients undergoing continuous ambulatory peritoneal dialysis after consuming or handling seafood; all patients recovered following appropriate antibiotic therapy [35–36]. In this case, traditional *V. vulnificus* sepsis treatment was combined with hemopurification, using HP and CVVHDF. This approach effectively controlled the inflammatory response, demonstrated by a significant decline in IL-6 levels (Fig. 1A), stabilized the internal environment, and maximized limb preservation. Hemopurification, when combined with conventional therapies, represents a promising approach for managing severe *V. vulnificus* infections in pediatric patients [37].

Conclusion

V. vulnificus infections are rare in children, and transwound infections progress rapidly to muscle tissue necrosis, usually accompanied by septic shock, resulting in high rates of disability and mortality. Early suspicion of *V. vulnificus* infection in children with immature immune systems is essential for prompt diagnosis and timely management. PCR-based bacterial culture can provide definitive pathogen identification, while dynamic monitoring of laboratory parameters aids in assessing disease progression and treatment efficacy. Early surgical debridement and decompression, combined with effective antibiotics (preferably cephalosporin III + tetracycline), anti-inflammatory therapy, and hemopurification to remove inflammatory mediators, stabilize the internal environment, and manage DIC, can significantly improve patient prognosis and survival rate. This approach offers a practical reference for diagnosing and managing *V. vulnificus* infections in pediatric patients.

Abbreviations

V. vulnificus	Vibrio vulnificus
CRP	C-reactive protein
PCT	Procalcitonin
PICU	Paediatric intensive care unit
WBC	White blood cell
NE	Neutrophil
Hb	Hemoglobin
PLT	Platelet
IL	Interleukin
PT	Prothrombin time
ALB	Albumin
APTT	Activated Partial Thromboplastin Time
NK	Natural killer
Treg	Regulatory T
IV	Intravenous
mNGS	Metagenomic next-generation sequencing
MetCap	High-throughput sequencing
HP	Hemoperfusion
CVVHDF	Continuous venovenous hemodiafiltration
PCR	Polymerase chain reaction
DIC	Disseminated intravascular coagulation
VSD	Vacuum Sealing Drainage
CRRT	Continuous renal replacement therapy

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-10691-2.

Supplementary Material 1

Supplementary Material 2

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Author contributions

Zj P: Formal analysis, Investigation, Data curation, Writing–original draft, manuscript revision, Visualization. Xh G: Visualization Revision, Editing - revision manuscript. Pp H: Editing- revision manuscript. L D: revision manuscript- Review.W H: Revision visualization. Yw X Writing–review & editing, Supervision, Funding acquisition, revision editing and review. Sc L Conceptualization, Methodology, Resources, Chief writing–review &editing, Supervision, Project administration, Funding acquisition，Head of PICU. All authors reviewed the revised manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethical approval and consent to participate

This study was approved by the Ethical Committee of Zhuhai Center for Maternal and Child Health Care, Zhuhai, PR China.(Approval number:2024(75)). Clinical trial number: not applicable.

Consent for publication
Written informed consent for publication of their clinical details and/or clinical images was obtained from the parent of the patient. A copy of the written consent is available for review by the Editor of this journal.

Competing interests
The authors declare no competing interests.

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