

World Journal of *Clinical Cases*

World J Clin Cases 2021 July 26; 9(21): 5754-6177



Contents

Thrice Monthly Volume 9 Number 21 July 26, 2021

REVIEW

- 5754 Treatment strategies for hepatocellular carcinoma with extrahepatic metastasis
Long HY, Huang TY, Xie XY, Long JT, Liu BX

MINIREVIEWS

- 5769 Prevention of hepatitis B reactivation in patients requiring chemotherapy and immunosuppressive therapy
Shih CA, Chen WC
- 5782 Research status on immunotherapy trials of gastric cancer
Liang C, Wu HM, Yu WM, Chen W
- 5794 Therapeutic plasma exchange for hyperlipidemic pancreatitis: Current evidence and unmet needs
Zheng CB, Zheng ZH, Zheng YP
- 5804 Essentials of thoracic outlet syndrome: A narrative review
Chang MC, Kim DH

ORIGINAL ARTICLE

Case Control Study

- 5812 Soluble programmed death-1 is predictive of hepatitis B surface antigen loss in chronic hepatitis B patients after antiviral treatment
Tan N, Luo H, Kang Q, Pan JL, Cheng R, Xi HL, Chen HY, Han YF, Yang YP, Xu XY

Retrospective Cohort Study

- 5822 Tunneled biopsy is an underutilised, simple, safe and efficient method for tissue acquisition from subepithelial tumours
Koutsoumpas A, Perera R, Melton A, Kuker J, Ghosh T, Braden B

Retrospective Study

- 5830 Macular ganglion cell complex injury in different stages of anterior ischemic optic neuropathy
Zhang W, Sun XQ, Peng XY
- 5840 Value of refined care in patients with acute exacerbation of chronic obstructive pulmonary disease
Na N, Guo SL, Zhang YY, Ye M, Zhang N, Wu GX, Ma LW
- 5850 Facilitators and barriers to colorectal cancer screening in an outpatient setting
Samuel G, Kratzer M, Asagbra O, Kinderwater J, Poola S, Udom J, Lambert K, Mian M, Ali E
- 5860 Development and validation of a prognostic nomogram for colorectal cancer after surgery
Li BW, Ma XY, Lai S, Sun X, Sun MJ, Chang B

Observational Study

- 5873** Potential protein-phenotype correlation in three lipopolysaccharide-responsive beige-like anchor protein-deficient patients

Tang WJ, Hu WH, Huang Y, Wu BB, Peng XM, Zhai XW, Qian XW, Ye ZQ, Xia HJ, Wu J, Shi JR

- 5889** Quantification analysis of pleural line movement for the diagnosis of pneumothorax

Xiao R, Shao Q, Zhao N, Liu F, Qian KJ

Prospective Study

- 5900** Preprocedure ultrasound imaging combined with palpation technique in epidural labor analgesia

Wu JP, Tang YZ, He LL, Zhao WX, An JX, Ni JX

Randomized Controlled Trial

- 5909** Effects of perioperative rosuvastatin on postoperative delirium in elderly patients: A randomized, double-blind, and placebo-controlled trial

Xu XQ, Luo JZ, Li XY, Tang HQ, Lu WH

SYSTEMATIC REVIEWS

- 5921** Pain assessment and management in the newborn: A systematized review

Garcia-Rodriguez MT, Bujan-Bravo S, Seijo-Bestilleiro R, Gonzalez-Martin C

META-ANALYSIS

- 5932** Fatigue prevalence in men treated for prostate cancer: A systematic review and meta-analysis

Luo YH, Yang YW, Wu CF, Wang C, Li WJ, Zhang HC

CASE REPORT

- 5943** Diagnostic discrepancy between colposcopy and vaginoscopy: A case report

Li Q, Zhang HW, Sui L, Hua KQ

- 5948** Contrast enhanced ultrasound in diagnosing liver lesion that spontaneously disappeared: A case report

Wang ZD, Haitham S, Gong JP, Pen ZL

- 5955** COVID-19 patient with an incubation period of 27 d: A case report

Du X, Gao Y, Kang K, Chong Y, Zhang ML, Yang W, Wang CS, Meng XL, Fei DS, Dai QQ, Zhao MY

- 5963** Awake extracorporeal membrane oxygenation support for a critically ill COVID-19 patient: A case report

Zhang JC, Li T

- 5972** Meigs syndrome with pleural effusion as initial manifestation: A case report

Hou YY, Peng L, Zhou M

- 5980** Giant hemangioma of the caudate lobe of the liver with surgical treatment: A case report

Wang XX, Dong BL, Wu B, Chen SY, He Y, Yang XJ

- 5988** Anti-programmed cell death ligand 1-based immunotherapy in recurrent hepatocellular carcinoma with inferior vena cava tumor thrombus and metastasis: Three case reports
Liu SR, Yan Q, Lin HM, Shi GZ, Cao Y, Zeng H, Liu C, Zhang R
- 5999** Minimal deviation adenocarcinoma with elevated CA19-9: A case report
Dong Y, Lv Y, Guo J, Sun L
- 6005** Isolated fungus ball in a single cell of the left ethmoid roof: A case report
Zhou LQ, Li M, Li YQ, Wang YJ
- 6009** Rare case of brucellosis misdiagnosed as prostate carcinoma with lumbar vertebra metastasis: A case report
Yan JF, Zhou HY, Luo SF, Wang X, Yu JD
- 6017** Myeloid sarcoma of the colon as initial presentation in acute promyelocytic leukemia: A case report and review of the literature
Wang L, Cai DL, Lin N
- 6026** Primary follicular lymphoma in the renal pelvis: A rare case report
Shen XZ, Lin C, Liu F
- 6032** Rosai-Dorfman disease in the spleen of a pediatric patient: A case report
Ryu H, Hwang JY, Kim YW, Kim TU, Jang JY, Park SE, Yang EJ, Shin DH
- 6041** Relapsed/refractory classical Hodgkin lymphoma effectively treated with low-dose decitabine plus tislelizumab: A case report
Ding XS, Mi L, Song YQ, Liu WP, Yu H, Lin NJ, Zhu J
- 6049** Disseminated *Fusarium* bloodstream infection in a child with acute myeloid leukemia: A case report
Ning JJ, Li XM, Li SQ
- 6056** Familial hemophagocytic lymphohistiocytosis type 2 in a female Chinese neonate: A case report and review of the literature
Bi SH, Jiang LL, Dai LY, Wang LL, Liu GH, Teng RJ
- 6067** Usefulness of metagenomic next-generation sequencing in adenovirus 7-induced acute respiratory distress syndrome: A case report
Zhang XJ, Zheng JY, Li X, Liang YJ, Zhang ZD
- 6073** Neurogenic orthostatic hypotension with Parkinson's disease as a cause of syncope: A case report
Li Y, Wang M, Liu XL, Ren YF, Zhang WB
- 6081** SATB2-associated syndrome caused by a novel SATB2 mutation in a Chinese boy: A case report and literature review
Zhu YY, Sun GL, Yang ZL
- 6091** Diagnosis and treatment discussion of congenital factor VII deficiency in pregnancy: A case report
Yang Y, Zeng YC, Rumende P, Wang CG, Chen Y

- 6102** Unusual immunohistochemical “null” pattern of four mismatch repair proteins in gastric cancer: A case report
Yue M, Liu JY, Liu YP
- 6110** Generalized periodontitis treated with periodontal, orthodontic, and prosthodontic therapy: A case report
Kaku M, Matsuda S, Kubo T, Shimoe S, Tsuga K, Kurihara H, Tanimoto K
- 6125** Ligamentum flavum hematoma following a traffic accident: A case report
Yu D, Lee W, Chang MC
- 6130** Oral cyclophosphamide-induced posterior reversible encephalopathy syndrome in a patient with ANCA-associated vasculitis: A case report
Kim Y, Kwak J, Jung S, Lee S, Jang HN, Cho HS, Chang SH, Kim HJ
- 6138** Encapsulating peritoneal sclerosis in an AMA-M2 positive patient: A case report
Yin MY, Qian LJ, Xi LT, Yu YX, Shi YQ, Liu L, Xu CF
- 6145** Multidisciplinary diagnostic dilemma in differentiating Madelung’s disease – the value of superb microvascular imaging technique: A case report
Seskute G, Dapkute A, Kausaite D, Strainiene S, Talijunas A, Butrimiene I
- 6155** Complicated course of biliary inflammatory myofibroblastic tumor mimicking hilar cholangiocarcinoma: A case report and literature review
Strainiene S, Sedleckaite K, Jarasunas J, Savlan I, Stanaitis J, Stundiene I, Strainys T, Liakina V, Valantinas J
- 6170** Fruquintinib beneficial in elderly patient with neoplastic pericardial effusion from rectal cancer: A case report
Zhang Y, Zou JY, Xu YY, He JN

ABOUT COVER

Editorial Board Member of *World Journal of Clinical Cases*, Jae Gil Lee, MD, PhD, Professor, Surgeon, Department of Surgery, Yonsei University College of Medicine, Seoul 03722, South Korea. jakii@yuhs.ac

AIMS AND SCOPE

The primary aim of *World Journal of Clinical Cases* (WJCC, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

INDEXING/ABSTRACTING

The WJCC is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2021 Edition of Journal Citation Reports® cites the 2020 impact factor (IF) for WJCC as 1.337; IF without journal self cites: 1.301; 5-year IF: 1.742; Journal Citation Indicator: 0.33; Ranking: 119 among 169 journals in medicine, general and internal; and Quartile category: Q3. The WJCC's CiteScore for 2020 is 0.8 and Scopus CiteScore rank 2020: General Medicine is 493/793.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Ji-Hong Lin; Production Department Director: Xiang Li; Editorial Office Director: Jin-Li Wang.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Dennis A Bloomfield, Sandro Vento, Bao-Gan Peng

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

July 26, 2021

COPYRIGHT

© 2021 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>



Disseminated *Fusarium* bloodstream infection in a child with acute myeloid leukemia: A case report

Jun-Jie Ning, Xue-Mei Li, Sheng-Qiu Li

ORCID number: Jun-Jie Ning 0000-0002-8555-5480; Xue-Mei Li 0000-0002-5994-903X; Sheng-Qiu Li 0000-0001-5333-9276.

Author contributions: Ning JJ was the patient's doctor, reviewed the literature, and contributed to drafting the manuscript; Li XM provided the plans for the treatment; Li SQ was the nurse in charge of the child and provided skin pictures of various periods; all authors issued final approval of the version to be submitted.

Informed consent statement:

Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

Conflict-of-interest statement: The authors declare that they have no conflicts of interest to report.

CARE Checklist (2016) statement:

The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution

Jun-Jie Ning, Xue-Mei Li, Sheng-Qiu Li, Department of PICU, First People's Hospital of Zigong City, Zigong 643000, Sichuan Province, China

Corresponding author: Jun-Jie Ning, MD, Doctor, Department of PICU, First People's Hospital of Zigong City, No. 42 Yizhi Road, Shangyihao, Zigong 643000, Sichuan Province, China. nestlord@foxmail.com

Abstract

BACKGROUND

Disseminated *Fusarium* is rare in healthy children. Children with hematological tumors may have secondary fungal infections, including *Fusarium* infections, which are due to tumor bone marrow infiltration or prolonged bone marrow suppression after chemotherapy. Because of the lack of typical clinical manifestations and effective antifungal drugs, early diagnosis and treatment of the disease are difficult, and the prognosis is poor.

CASE SUMMARY

The patient in this case was a 13-year-old female child with rash and fever as the first symptoms. She had the characteristics of the four stages of skin that are typical of *Fusarium* infection. She was diagnosed with disseminated *Fusarium* infection through skin biopsy and blood culture and diagnosed with *Fusarium solani* infection based on the morphological characteristics of the blood culture. After treatment with liposome amphotericin B combined with voriconazole, the child recovered.

CONCLUSION

This case highlights that for children with secondary agranulocytosis after receiving chemotherapy for hematological malignancies, once typical abnormal skin damage is found, the possibility of *Fusarium* infection should be considered, and voriconazole alone or in combination with polyenes may be the most effective anti-*Fusarium* drugs. Amphotericin B, the traditional drug of disseminated *Fusarium* disease, has a high mortality rate, and it is not recommended to use it alone. Adequate neutrophil counts are essential for the treatment of disseminated *Fusarium* bloodstream infection.

Key Words: *Fusarium*; Liposomal amphotericin B; Voriconazole; Acute myeloid leukemia; Agranulocytosis; Case report

NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Manuscript source: Unsolicited manuscript

Specialty type: Medicine, research and experimental

Country/Territory of origin: China

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): 0
Grade D (Fair): 0
Grade E (Poor): 0

Received: February 22, 2021

Peer-review started: March 2, 2021

First decision: March 25, 2021

Revised: April 6, 2021

Accepted: May 25, 2021

Article in press: May 25, 2021

Published online: July 26, 2021

P-Reviewer: Niu J

S-Editor: Gao CC

L-Editor: Wang TQ

P-Editor: Xing YX



©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

Core Tip: We present herein the case of a *Fusarium* infection female child with rash and fever as the first symptoms. She had the characteristics of the four stages of skin typical of *Fusarium* infection. She was diagnosed with disseminated *Fusarium* infection through blood culture. For children with secondary agranulocytosis after receiving chemotherapy for hematological malignancies, once typical abnormal skin damage is found, the possibility of *Fusarium* infection should be considered, and the key to treatment is early diagnosis, the reversal of immunosuppression, and the provision of the correct antifungal treatment as soon as possible.

Citation: Ning JJ, Li XM, Li SQ. Disseminated *Fusarium* bloodstream infection in a child with acute myeloid leukemia: A case report. *World J Clin Cases* 2021; 9(21): 6049-6055

URL: <https://www.wjgnet.com/2307-8960/full/v9/i21/6049.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v9.i21.6049>

INTRODUCTION

Fusarium was discovered in 1958 and is a common soil mold. It was once considered to be pathogenic only in plants and to be able to cause devastating diseases in plants and crops[1]. However, Cho *et al*[2] first reported a case of disseminated *Fusarium* bloodstream infection in a child with acute myeloid leukemia in 1973 and found that *Fusarium* could also infect humans. With the increasing number of patients with low immune function, *Fusarium* is considered to be the second most common filamentous fungus that causes opportunistic infections after *Aspergillus*, and *Fusarium* infections are reported every year[3]. In this study, the clinical manifestations, diagnosis, and treatment of a case of disseminated *Fusarium* bloodstream infection in a child with acute myeloid leukemia are reported to provide a reference for future clinical treatment.

CASE PRESENTATION

Chief complaints

The patient, a 13-year-old Chinese girl, came to our hospital because she had a pale complexion for 1 mo.

History of present illness

One month prior to presentation, the child appeared pale, which gradually worsened. Laboratory examination indicated the following: White blood cell count (WBC) $1.54 \times 10^9/L$, N% 7.9%, hemoglobin (Hb) 47 g/L, and platelets (PLT) $64 \times 10^9/L$. The results of bone marrow cell morphology, immunology, and cellular and molecular genetics (MICM typing) confirmed acute myeloid leukemia (type M1). Then, the patient received induction DA chemotherapy (daunorubicin for 3 d and cytarabine for 7 d).

History of past illness

The patient had an unremarkable previous medical history.

Personal and family history

The patient's personal and family history was nothing special.

Physical examination

On the third day after induction chemotherapy, the child developed a high fever. Physical examination revealed maculopapules on the face, trunk, and extremities (Figure 1A). The rash was further aggravated, mainly on the trunk, with obvious tenderness, part of the rash showed central necrosis and obvious peripheral swelling (Figure 1B), and part of the rash manifested vesicular formations (Figure 1C). Subsequently, the rash further changed, and the vesicular lesions ruptured to form

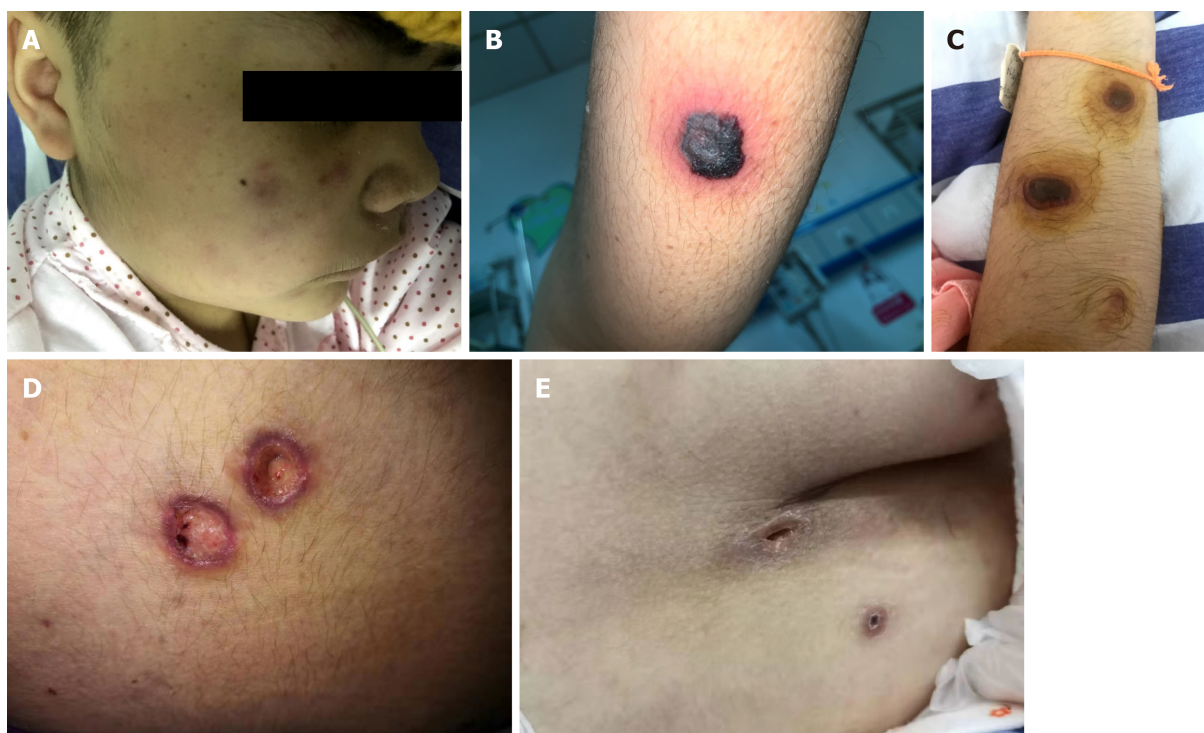


Figure 1 Skin lesions. A: The cheeks, limbs, and trunk began to show purple macules with mild itching; B: Papules protruded from the body surface, with black necrotic tissue visible in the center, peripheral redness and swelling, and accompanying pain; C: Herpes-like lesions with pus were seen in the center of the rash; D: Once the scabs fell off, the affected areas developed into deep ulcers; E: The ulcers gradually healed, leaving scars.

crater-like ulcers (Figure 1D).

Laboratory examinations

Myelosuppression occurred during chemotherapy, repeated full blood examination demonstrated persistent neutropenia (WBC $0.12 \times 10^9/L$ and absolute neutrophil count $0.01 \times 10^9/L$), and C-reactive protein was 296.5 mg/L. Two repeated fungal antigen tests [galactomannan (GM) and β -D-glucan] were negative.

Imaging examinations

Computed tomography (CT) examination of the chest and abdomen showed no involvement of deep organs.

Microbiological identification of the causative agent

The blood culture grew a fungus, which was ultimately identified as *Fusarium solani* by morphological characteristics (Figure 2). Fungi were seen on the biopsy of the exfoliated scab (Figure 3).

FINAL DIAGNOSIS

The final diagnosis of the presented case was disseminated *Fusarium* bloodstream infection.

TREATMENT

This child had febrile neutropenia, combined with skin rash as the main clinical manifestation. On the basis of imipenem and cilastatin sodium anti-infection, vancomycin was added to cover Gram-positive microorganisms. Fluconazole was used to prevent fungal infection, and granulocyte colony-stimulating factor was used to promote the recovery of hematopoietic function. However, the rash was further aggravated, and the child still suffered from repeated high fever and altered conscious state and feeding. The antibacterial drugs imipenem and cilastatin sodium and

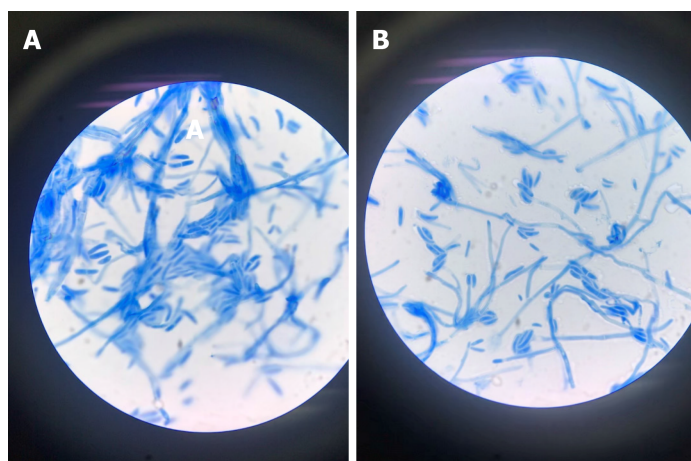


Figure 2 Microscopic images (1000 ×) of *Fusarium solani* stained with lactophenol cotton blue. A: The macroconidia are stout and sickle-shaped; B: Septated hyphae with straight simple thin long phialide bearing oval microconidia in a “diphtheroidal” pattern.

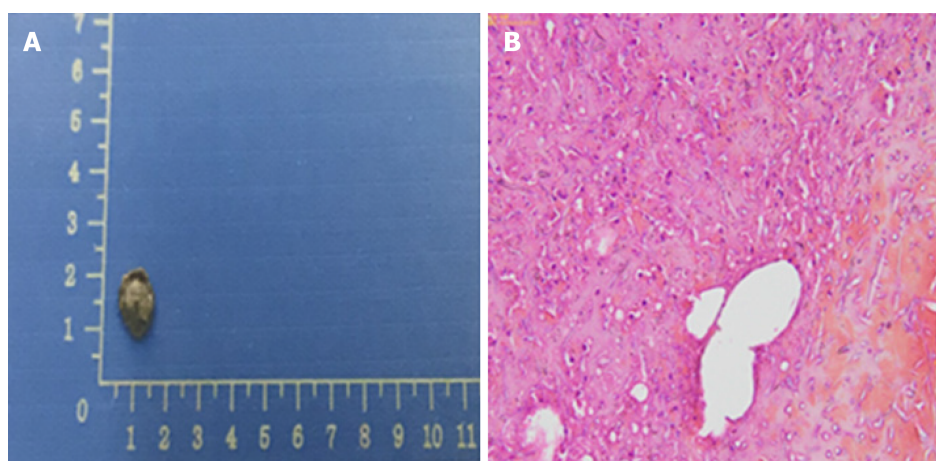


Figure 3 Fungi were seen on the biopsy of the exfoliated scab. A: Exfoliated scab examination; B: Fungi can be seen in the scab.

vancomycin continued to be given to treat infection. Considering the high drug-resistance rate of *Fusarium* and the poor prognosis of patients with low immunity and disseminated *Fusarium* infection, fluconazole was changed to voriconazole and liposomal amphotericin B to ensure that at least one drug was effective (Figure 4). After the body temperature stabilized, the antibiotic regimen was downgraded to cefoperazone sodium and sulbactam sodium for continued prevention of infection, and the administration of liposomal amphotericin B combined with voriconazole antifungal treatment was continued for 4 wk.

OUTCOME AND FOLLOW-UP

The child had a fever for 14 d. After that, the body temperature was normal, and the necrotic rash gradually healed (Figure 1E). Routine blood re-examination showed the following: WBC $8.76 \times 10^9/L$, neutrophil $7.26 \times 10^9/L$, Hb 70 g/L, PLT $35 \times 10^9/L$, and CRP 88.7 mg/L. However, before discharge, a 4 cm × 1.5 cm mass was palpable in the right calf of the child, and the tenderness was obvious. B-scan ultrasonography showed the formation of a local abscess, and CT examination of the chest and abdomen showed no involvement of deep organs. The discharge instructions were to continue posaconazole oral suspension combined with cefixime for anti-infection treatment for 2 wk. Eventually, the clinical symptoms of the child disappeared, the blood culture was negative on re-examination, and a clinical cure was achieved. There were no obvious adverse drug reactions during the treatment. However, the second cycle of chemotherapy was delayed because of the fungal infection. At present, the child is generally in good condition, and a second round of chemotherapy is planned.

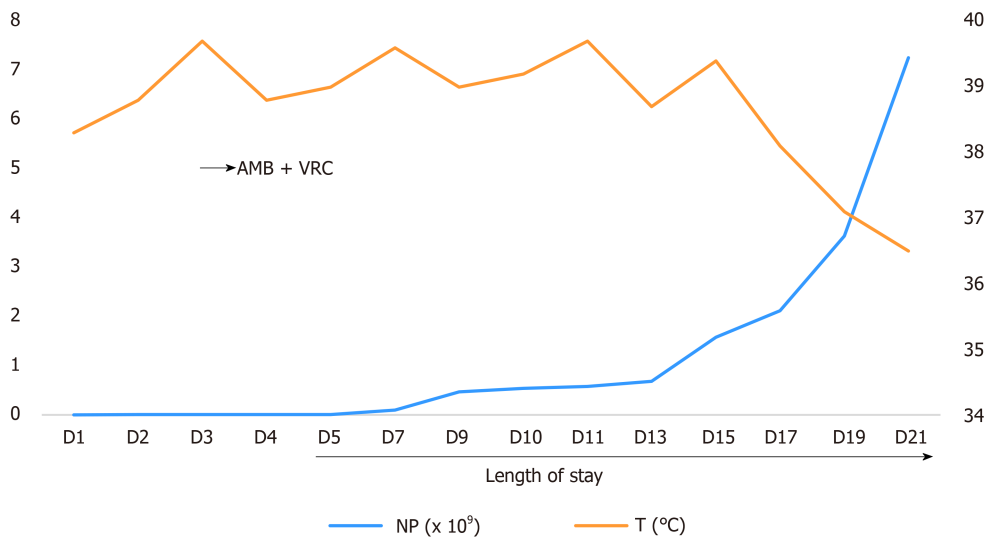


Figure 4 Changes in body temperature and neutrophils before and after medication (D5: The growth of *Fusarium* in blood culture). AMB: Amphotericin B; VRC: Voriconazole; NP: Neutrophil.

DISCUSSION

Fusarium is a saprophytic fungus with strong ecological adaptability. It is widely distributed in natural soils and plants and can even live in deserts and Arctic regions. It can be parasitic on animal and plant bodies or saprophytic in animal and plant debris. Some species can produce mycotoxins under certain circumstances and threaten the health of humans and animals[4]. A multicenter retrospective study indicated a significantly increased incidence of *Fusarium* infection in patients with immunosuppression and acute myeloid leukemia, and this type of infection ranks second only to *Aspergillus* infection[5]. For people with normal immunity, *Fusarium* is an opportunistic pathogen, mainly causing local infections[6], but for patients with hematological malignancies, aplastic anemia, and organ transplantation or undergoing chemotherapy, *Fusarium* can cause invasive fungal infections. Among these patients with low immune function, disseminated *Fusarium* disease accounts for 70% of *Fusarium* infections[7].

In immunocompromised hosts, the lack of a normal immune response can lead to vascular infiltration of *Fusarium*, leading to necrosis and diffuse infection, with skin involvement in 70% of cases of *Fusarium* infection[8]. The characteristic skin lesions may provide guidance for the early diagnosis of *Fusarium* infection. A typical *Fusarium* infection-induced rash can be divided into four periods: Stage I, red maculopapular rash; stage II, necrosis in the center of the rash; stage III, vesicular bullae changes secondary to necrosis; and stage IV, after the eruption, the vesicular lesions change to cratered lesions and eventually heal. Each period of skin change is 1-2 d apart[9]. The rash in this case showed typical four-stage manifestations. This study found that the four stages of *Fusarium* skin lesions can coexist, and in stage III, the vesicular lesions presented as thick-walled blisters with cloudy pus, and pain was obvious during the rash. Although the rash caused by *Fusarium* infection is specific, it still needs to be distinguished from the rash of patients with neutropenia, including leukemic deposits, viral infections, bacterial infections (ecthyma gangrenosum), and other fungi (*Aspergillus*, mucormycosis, and *Candida*) causing skin lesions.

Fusarium infection is difficult to cure and has a poor prognosis; the overall mortality is as high as 50%-70%[10], and there is no consensus on the management of invasive disseminated *Fusarium* infection in the case of neutropenia. At present, the key to successful treatment is early diagnosis, the reversal of immunosuppression, and the administration of the correct antifungal treatment as soon as possible; however, *Fusarium* has shown widespread resistance to antifungal drugs *in vitro*. *In vitro* studies suggest that fluconazole, itraconazole, and flucytosine are not effective against *Fusarium*, while ketoconazole, miconazole, terbinafine, and voriconazole have limited efficacy. Amphotericin B is considered to be the most effective anti-*Fusarium* drug *in vitro*. However, Nucci *et al*[7] showed that the mortality rate of amphotericin B in the treatment of disseminated *Fusarium* was as high as 70%. The current successful

treatment often comes from cases of voriconazole, so voriconazole alone or in combination with polyenes has been increasingly used for *Fusarium* infections. Because of the high drug resistance rate of *Fusarium*, the use of a single drug for the treatment of drug-resistant fungi cannot achieve a satisfactory effect, but a major concern for combination therapy is the potential antagonistic effect between antifungal agents. Some studies have shown that liposomal amphotericin B combined with voriconazole has a synergistic effect in the treatment of drug-resistant fungi[11]. Ho *et al*[12] also pointed out that for patients with increased skin lesions or continuous positive blood culture in monotherapy, the combination of the two drugs for treatment could be considered.

Other studies have proposed that granulocyte recovery is the most important factor for successful treatment of invasive *Fusarium* infection. For patients with agranulocytosis, even if systemic antifungal drugs are given, the fatality rate is still close to 100%[13]. Therefore, colony-stimulating factor (G-CSF) and/or GM-CSF should be given to promote or maintain the recovery of hematopoietic function. Another finding suggests that surgical removal of focal lesions may result in better outcomes in patients with skin or disseminated infections[3].

CONCLUSION

For children with secondary agranulocytosis after receiving chemotherapy for hematological malignancies, once the typical abnormal skin damage is found, it should be alert to the possibility of *Fusarium* infection, and the key to treatment is early diagnosis, reversal of immunosuppression, and correct antifungal treatment as soon as possible. Voriconazole alone or in combination with polyenes may be the most effective anti-*Fusarium* drugs.

ACKNOWLEDGEMENTS

All authors thank all doctors and nurses of PICU.

REFERENCES

- 1 **Urbaniak C**, Dadwal S, Bagranyan K, Venkateswaran K. Draft Genome Sequence of a Clinical Isolate of *Fusarium fujikuroi* Isolated from a Male Patient with Acute Myeloid Leukemia. *Genome Announc* 2018; **6** [PMID: 29930033 DOI: 10.1128/genomeA.00476-18]
- 2 **Cho CT**, Vats TS, Lowman JT, Brandsberg JW, Tosh FE. *Fusarium solani* infection during treatment for acute leukemia. *J Pediatr* 1973; **83**: 1028-1031 [PMID: 4518930 DOI: 10.1016/s0022-3476(73)80543-8]
- 3 **Muhammed M**, Anagnostou T, Desalermos A, Kourkoumpetis TK, Carneiro HA, Glavis-Bloom J, Coleman JJ, Mylonakis E. *Fusarium* infection: report of 26 cases and review of 97 cases from the literature. *Medicine (Baltimore)* 2013; **92**: 305-316 [PMID: 24145697 DOI: 10.1097/MD.0000000000000008]
- 4 **Antonissen G**, Martel A, Pasmans F, Ducatelle R, Verbrugghe E, Vandenbroucke V, Li S, Haesebrouck F, Van Immerseel F, Croubels S. The impact of *Fusarium* mycotoxins on human and animal host susceptibility to infectious diseases. *Toxins (Basel)* 2014; **6**: 430-452 [PMID: 24476707 DOI: 10.3390/toxins6020430]
- 5 **Pagano L**, Caira M, Candoni A, Offidani M, Fianchi L, Martino B, Pastore D, Picardi M, Bonini A, Chierichini A, Fanci R, Caramatti C, Invernizzi R, Mattei D, Mitra ME, Melillo L, Aversa F, Van Lint MT, Falcucci P, Valentini CG, Girmenia C, Nosari A. The epidemiology of fungal infections in patients with hematologic malignancies: the SEIFEM-2004 study. *Haematologica* 2006; **91**: 1068-1075 [PMID: 16885047 DOI: 10.1016/j.exphem.2006.05.021]
- 6 **Musa MO**, Al Eisa A, Halim M, Sahovic E, Gyger M, Chaudhri N, Al Mohareb F, Seth P, Aslam M, Aljurf M. The spectrum of *Fusarium* infection in immunocompromised patients with haematological malignancies and in non-immunocompromised patients: a single institution experience over 10 years. *Br J Haematol* 2000; **108**: 544-548 [PMID: 10759712 DOI: 10.1046/j.1365-2141.2000.01856.x]
- 7 **Nucci M**, Marr KA, Queiroz-Telles F, Martins CA, Trabasso P, Costa S, Voltarelli JC, Colombo AL, Imhof A, Pasquini R, Maiolino A, Souza CA, Anaissie E. *Fusarium* infection in hematopoietic stem cell transplant recipients. *Clin Infect Dis* 2004; **38**: 1237-1242 [PMID: 15127334 DOI: 10.1086/383319]
- 8 **Boutati EI**, Anaissie EJ. *Fusarium*, a significant emerging pathogen in patients with hematologic malignancy: ten years' experience at a cancer center and implications for management. *Blood* 1997; **90**: 999-1008 [PMID: 9242529 DOI: 10.1016/S0951-8320(97)00023-9]

- 9 **Nucci M**, Anaissie E. Cutaneous infection by *Fusarium* species in healthy and immunocompromised hosts: implications for diagnosis and management. *Clin Infect Dis* 2002; **35**: 909-920 [PMID: [12355377](#) DOI: [10.1086/342328](#)]
- 10 **Nambiar P**, Cober E, Johnson L, Brizendine KD. Fatal *Fusarium* infection manifesting as osteomyelitis following previous treatment with amphotericin B in a multi-visceral transplant: Case report and review of *Fusarium* infections in solid organ transplantation. *Transpl Infect Dis* 2018; **20**: e12872 [PMID: [29512240](#) DOI: [10.1111/tid.12872](#)]
- 11 **Martin-Vicente A**, Guarro J, Capilla J. Does a triple combination have better activity than double combinations against multiresistant fungi? Experimental *in vitro* evaluation. **49**: 422-426 [PMID: [28257903](#) DOI: [10.1016/j.ijantimicag.2016.12.015](#)]
- 12 **Ho DY**, Lee JD, Rosso F, Montoya JG. Treating disseminated fusariosis: amphotericin B, voriconazole or both? *Mycoses* 2007; **50**: 227-231 [PMID: [17472622](#) DOI: [10.1111/j.1439-0507.2006.01346.x](#)]
- 13 **Nucci M**, Anaissie E. *Fusarium* infections in immunocompromised patients. *Clin Microbiol Rev* 2007; **20**: 695-704 [PMID: [17934079](#) DOI: [10.1128/CMR.00014-07](#)]



Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA

Telephone: +1-925-3991568

E-mail: bpgoffice@wjgnet.com

Help Desk: <https://www.f6publishing.com/helpdesk>

<https://www.wjgnet.com>

