

A Case of Post-Traumatic *Klebsiella variicola* Sepsis Complicated by Multisite Invasive Infections (Osteomyelitis, hepatic abscess, and Urinary Tract Infection)

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Case Report

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Abstract

Background: *Klebsiella variicola* is a member of the *Klebsiella pneumoniae* species complex (KpSC) and is frequently misidentified as *Klebsiella pneumoniae* in routine clinical microbiological testing^{1,2}. In recent years, an increasing number of cases of bloodstream infection and pyogenic hepatic abscess caused by this pathogen have been reported; however, to date, no cases of *Klebsiella variicola*–associated osteomyelitis complicated by multi-site invasive infection have been documented.

Case presentation: A 79-year-old woman with long-standing, poorly controlled type 2 diabetes (HbA1c 11.1%) was admitted to the hospital following a fall and presenting with acute right shoulder pain. Shortly after admission, she rapidly developed sepsis that progressed to septic shock complicated by multiple organ dysfunction syndrome (MODS), necessitating transfer to the intensive care unit (ICU); her Sequential Organ Failure Assessment (SOFA) score upon ICU admission was 3. Contrast-enhanced computed tomography (CT) revealed extensive soft-tissue emphysema involving the right shoulder, cervical root, and axilla, as well as intramedullary gas within the right clavicle and scapula. Additional imaging findings included a hepatic abscess and evidence of urinary tract infection. Metagenomic next-generation sequencing (mNGS) of peripheral blood identified *Klebsiella variicola* (4731 unique reads). Cultures from bone-marrow aspirate, hepatic-abscess pus, and urine recovered isolates of *Klebsiella pneumoniae* or its species complex. The patient also had concurrent aspiration pneumonia, atrial fibrillation, diabetic ketoacidosis, thrombocytopenia, and hepatic insufficiency. Empiric antimicrobial therapy was initiated with imipenem-cilastatin sodium (500 mg intravenously every 6 hours), later de-escalated to piperacillin-tazobactam (4.5 g intravenously every 8 hours) guided by culture and susceptibility results. Concurrently, percutaneous drainage was performed for both the hepatic abscess and the pleural effusion. Following comprehensive antimicrobial and supportive therapy, her infection gradually resolved, and the patient was subsequently transferred from the intensive care unit (ICU) to a general ward.

Conclusion: This case represents the first reported instance of post-traumatic osteomyelitis caused by *Klebsiella variicola*, complicated by sepsis, hepatic abscess, and urinary tract infection. The causative pathogen exhibits an invasive phenotype resembling that of hypervirulent *Klebsiella pneumoniae* (hvKp). In patients with diabetes mellitus presenting with severe infection, careful strain-level identification is essential. Bone marrow aspiration and comprehensive microbiological evaluation should be performed promptly; metagenomic next-generation sequencing (mNGS) can facilitate early and accurate pathogen identification. Timely initiation of effective antimicrobial therapy, combined with adequate source control through drainage of infected lesions, is critical to improving patient outcomes.

Introduction

Klebsiella variicola, formally recognized as a distinct species within the genus *Klebsiella* in 2004¹, is a multi-host opportunistic pathogen. Conventional biochemical identification methods and standard MALDI-TOF mass spectrometry often fail to reliably differentiate *K. variicola* from *Klebsiella*

pneumoniae^{2,3}, leading to frequent clinical misidentification and a substantial underestimation of its true epidemiological burden. Whole-genome sequencing studies have revealed that a subset of infections historically reported as *K. pneumoniae* are, in fact, attributable to closely related species, including *Klebsiella variicola* and *Klebsiella quasipneumoniae*². Accurate species-level discrimination is now achievable through advanced diagnostic approaches, including optimized MALDI-TOF protocols, multiplex fluorescent PCR (KpSC-ID), and multilocus sequence typing (MLST)^{3,4}.

The spectrum of infections attributable to *Klebsiella variicola* continues to broaden, encompassing bloodstream infections, urinary tract infections, intra-abdominal infections, as well as meningitis¹. Among trauma patients, the incidence of *K. variicola*–associated bloodstream infections exceeds that of *Klebsiella pneumoniae*⁵; however, most isolates remain susceptible to commonly-used antibiotics, exhibiting a low prevalence of antimicrobial resistance⁵. Prior reports have documented *K. variicola*–mediated pyogenic hepatic abscesses complicated by endogenous endophthalmitis in diabetic patients⁶, as well as peritoneal-dialysis–associated peritonitis. Of note, outbreaks have occurred in neonatal intensive care units, with an associated case-fatality rate of up to 54.5%⁷. To date, however, no clinically confirmed cases of *K. variicola*–associated osteomyelitis have been reported in the literature.

Here, we describe a rare case of post-traumatic *K. variicola* sepsis presenting with clavicular and scapular osteomyelitis, a hepatic abscess, and a urinary tract infection. The patient improved after antimicrobial therapy and multi-site lesion drainage. This case broadens the known clinical disease spectrum associated with *K. variicola* and underscores the clinical value of precise pathogen identification and comprehensive intervention.

Case Report

General Information

A 79-year-old woman was admitted to the orthopedic department with a 7-day history of right shoulder pain and restricted range of motion. She had a > 10-year history of type 2 diabetes mellitus, characterized by suboptimal long-term glycemic control. On admission, she was afebrile and reported no chills; however, she endorsed significant fatigue.

Physical examination on admission:

body temperature, 36.4°C; pulse rate, 108 beats/min; respiratory rate, 20 breaths/min; blood pressure, 127/58 mmHg. The patient was alert and oriented. Auscultation revealed coarse breath sounds bilaterally, with bilateral basilar moist rales. Cardiac auscultation demonstrated an irregularly irregular rhythm. Abdominal examination was unremarkable. Palpable crepitus was noted in the right cervical region. The right shoulder and upper arm were swollen and tender, with limited range of motion at the glenohumeral joint. Peripheral perfusion and sensation in the extremities were intact.

Laboratory examinations:

blood-gas analysis: lactate, 2.5 mmol/L; hemoglobin, 9.2 g/dL; blood glucose, 15.4 mmol/L; pH, 7.441; partial pressure of carbon dioxide, 28.1 mmHg; partial pressure of oxygen, 150.0 mmHg; base excess, -4.2 mmol/L; oxygen saturation, 100.0% (face-mask oxygen supplementation); glycated hemoglobin, 11.1%; WBC, $12.16 \times 10^9/L$; neutrophil percentage, 93.5%; platelet count, $22 \times 10^9/L$; peak procalcitonin, 43.6 µg/L; interleukin-6, > 5000.00 pg/mL; PCT, 19.72 µg/L; CRP, 162 mg/L; AST, 68 U/L; ALT, 65 U/L; albumin, 23.49 g/L; total bilirubin, 39.3 µmol/L; creatinine, 79.1 µmol/L; PT, 13 s; PT-INR, 1.2; FIB, 4.56 g/L; APTT, 39.9 s; pro-BNP, 10148 ng/L.

Imaging:

Computed tomography (CT) of the right-shoulder joint revealed extensive soft-tissue swelling and pneumatosis involving the right shoulder, supraclavicular region, and axilla (Fig. 1A). In addition, scattered foci of pneumatosis were observed within the bone-marrow cavities of the right clavicle and scapula-findings consistent with infectious osteomyelitis.

Chest CT demonstrated soft-tissue swelling and minimal pneumatosis in the left chest wall; bilateral pulmonary opacities with scattered infiltrates, partial consolidation, and atelectasis; and bilateral pleural effusions. A slightly hypoattenuating mass-like lesion measuring approximately 3.4 × 3.1 cm was identified in the right hepatic lobe, showing peripheral rim enhancement on contrast-enhanced imaging (Fig. 1B). Ultrasound confirmed the hypoechoic lesion in the right hepatic lobe as well as bilateral pleural effusions.

Clinical Course and ICU Management:

On admission, the patient abruptly developed dyspnea and somnolence. Oxygen saturation declined (fluctuating between 85% and 90%), heart rate increased to 157 beats/min, respiratory rate was mildly elevated at 29 breaths/min, and blood pressure dropped to 77/44 mmHg. Marked elevation of inflammatory biomarkers was observed. Combined with CT imaging findings, the patient was diagnosed with sepsis complicated by septic shock and multiple-organ dysfunction syndrome (MODS), and was subsequently transferred to the ICU for initiation of septic-shock bundle therapy. Day 0 was defined as the day of ICU admission.

Point-of-care transthoracic echocardiography revealed an inferior vena cava (IVC) diameter of 1.3 cm, indicating hypovolemia. A passive leg-raise (PLR) test yielded a positive response, prompting immediate fluid resuscitation. Empiric antimicrobial therapy with intravenous imipenem–cilastatin (500 mg every 6 hours) was initiated.

Day 1: Blood mNGS analysis identified *Klebsiella variicola*, with 4731 unique sequence reads.

Day 2: CT-guided right acromial bone marrow biopsy was performed (Fig. 1C). Culture of the bone marrow aspirate yielded *Klebsiella* species, with an imipenem minimum inhibitory concentration (MIC) of 0.25 µg/mL. Histopathological examination revealed extensive neutrophilic infiltration within osseous and coagulated blood tissue (Fig. 1D). Urine culture performed on the same day also isolated the same *Klebsiella* species, with an identical antimicrobial susceptibility profile.

Day 3: Ultrasound-guided percutaneous catheter drainage of the hepatic abscess was performed; and purulent fluid was evacuated (Fig. 1E-F). Culture results identified *Klebsiella pneumoniae* subsp. *pneumoniae* (later confirmed as *Klebsiella variicola* via mNGS). Bilateral closed thoracic drainage was performed at the same time; fungal spores were observed in the pleural fluid smear, but pleural fluid culture was negative. Blood cultures were ultimately negative.

Antimicrobial regimen:

Upon ICU admission, imipenem–cilastatin (500 mg intravenously every 6 hours) was initiated and continued for 8 days. After significant improvement in infection markers, specifically a marked reduction in procalcitonin levels from 43.6 µg/L to 0.519 µg/L, and confirmation of microbiological susceptibility results, the regimen was de-escalated to piperacillin–tazobactam (4.5 g intravenously every 8 hours), to which the isolated pathogen demonstrated an MIC of 4 µg/mL.

Concurrently, aggressive source control was pursued via local-site drainage of infectious foci: daily drainage of hepatic abscess yielded 20 mL of purulent fluid; bilateral thoracentesis produced pale yellow and light red pleural effusions.

Clinical Course:

Following treatment, the patient's condition gradually improved.

Day 5: Hepatic ultrasound revealed a marked reduction in the fluid-filled area of the hepatic abscess.

Day 10: Follow-up CT demonstrated near-complete resolution of soft-tissue emphysema in the shoulder and cervical regions and decreased intramedullary gas; pulmonary infiltrates and pleural effusions also showed improvement compared with baseline. Vasopressor support was discontinued, mental status returned to baseline; and the patient resumed oral intake. After 10 days of treatment in the ICU, the patient was transferred back to the general orthopedic ward for further management. The clinical timeline is summarized in Table 1.

Table 1
Clinical timeline of the patient's hospital course

Phase	Clinical Events and Diagnostic Findings	Treatment
Pre-admission (7 days)	Right shoulder swelling, pain, and limited motion after a fall; long-standing diabetes with poor control (HbA1c 11.1%).	No specific anti-infective therapy.
Day of admission (Day 0)	Sudden dyspnea, hypotension, and altered mental status; septic shock, transferred to ICU. CT demonstrated soft-tissue emphysema in right shoulder, cervical region, and axilla, intramedullary gas within the clavicle and scapula, a hypoattenuating lesion in the right hepatic lobe, and bilateral pleural effusions.	Fluid resuscitation; empirical imipenem–cilastatin (500 mg every 6 hours).
Day 1	Blood mNGS identified <i>Klebsiella variicola</i> (4731 specific reads), confirming the pathogen.	Continue current regimen pending susceptibility results.
Day 2	Bone-marrow biopsy: culture grew <i>Klebsiella</i> species (imipenem-susceptible); histopathology showed dense neutrophilic infiltration. Urine culture yielded the same organism with a susceptible antimicrobial-susceptibility profile.	Confirmation of infection foci; basis for subsequent regimen adjustment.
Day 3	Ultrasound-guided drainage of the hepatic abscess; purulent fluid was obtained. Bilateral closed-chest thoracic drainage was performed.	Complete multi-site drainage to enhance source control.
Day 5–8	Infection markers (PCT) declined markedly; hepatic abscess size reduced.	On Day 8, de-escalated to piperacillin-tazobactam (4.5 g every 8 hours) based on susceptibility.
Day 10	Follow-up CT showed near-complete resolution of emphysema, improved pulmonary infiltrates, and reduced pleural effusions. Vasopressors were discontinued, mental status returned to baseline, and oral intake was resumed.	Transferred back to the general orthopedic ward for further care.

Discussion

This case demonstrates that *Klebsiella variicola* can produce a highly invasive clinical phenotype resembling hypervirulent *Klebsiella pneumoniae* syndrome. To our knowledge, it is the first documented case of post-traumatic osteomyelitis caused by this pathogen, adding to the growing body of evidence that *K. variicola* is capable of life-threatening disseminated infection. The findings highlight the importance of precise species-level identification within the *K. pneumoniae* complex and underscore the need for heightened clinical awareness, particularly in diabetic patients with seemingly minor trauma.

Clinical Implications of Pathogen Identification

This case illustrates the practical challenges in clinical identification of *Klebsiella variicola*⁸. In this instance, conventional culture of bone marrow, pus, and urine yielded only *Klebsiella pneumoniae*; definitive identification as *K. variicola* was achieved solely through mNGS of peripheral blood⁸. Conventional biochemical assays and standard MALDI-TOF mass spectrometry are inherently limited in their ability to discriminate among members of the *K. pneumoniae* species complex, a well-documented source of diagnostic misclassification in clinical practice^{2,3}. Moreover, *Klebsiella variicola* is particularly prone to being overlooked in urine cultures⁹. In critically ill patients with diabetes presenting with culture-confirmed *Klebsiella*-like infection-yet exhibiting rapid sepsis progression and multiple invasive abscesses-clinicians must maintain a high index of suspicion for members of the *K. pneumoniae* species complex, including rare variants such as *K. variicola*. mNGS thus serves as a valuable complementary tool for accurate species-level identification when conventional culture-based methods are insufficient⁸.

Virulence potential of *Klebsiella variicola*

In our case, the *Klebsiella variicola* isolate was fully susceptible to β -lactam agents yet induced severe sepsis, thrombocytopenia and multiple organ abscesses. This underscores that in vitro antimicrobial susceptibility does not preclude robust invasive and disseminative virulence in this pathogen¹⁰. Accumulating evidence has confirmed the hypervirulent potential of *K. variicola*, with documented life-threatening manifestations, including intracranial infection, fatal sepsis in patients with diabetes or COVID-19-associated complications, and rapidly progressive bloodstream infection^{11–13}. These clinical phenotypes align closely with our own findings.

Previous outbreaks in neonatal intensive care units (NICUs) have further demonstrated the aggressive pathogenic capacity of *Klebsiella* species⁷. The present case, characterized by antibiotic susceptibility coupled with marked invasiveness, suggests that *K. variicola* may independently evolve virulence and resistance determinants. Additionally, strains carrying heavy metal-resistance plasmids have been implicated in severe neonatal infections and may pose a significant risk for nosocomial transmission¹⁴. Clinically, heightened vigilance is essential for sporadic, severe infections caused by *K. variicola*. Its low antimicrobial resistance profile should never be interpreted as an indicator of low pathogenic risk⁷; hypervirulence and clinical severity must be assessed independently of conventional susceptibility results.

Gas-forming osteomyelitis

Klebsiella pneumoniae osteomyelitis is rare, and all previously reported cases have been attributed to *Klebsiella pneumoniae*. This is the first documented case of osteomyelitis caused by *Klebsiella variicola*. Intramedullary gas identified on CT imaging originates from bacterial gas production, which aggravates local tissue destruction and accelerates spread along fascial planes, representing a key driver of rapid infection dissemination and abrupt clinical deterioration in this patient. Notably, the gas-producing capacity of *Klebsiella variicola* is not limited to soft tissues and bone. Dahl et al.¹⁵ reported a case of gas-forming hepatic abscess caused by coinfection with *Clostridium perfringens* and *Klebsiella variicola*.

after total pancreatectomy; the patient developed severe sepsis, further suggesting the pathogenic potential of this species in gas-generating invasive infections.

This case has a robust diagnostic evidence-base: characteristic imaging manifestations of gas-forming osteomyelitis, extensive neutrophilic infiltration on bone biopsy, positive bone-marrow aspirate culture, species-level confirmation by blood mNGS, and exclusion of other coinfecting pathogens. Accordingly, for elderly diabetic patients who develop bone-joint pain and soft-tissue swelling following minor trauma, prompt imaging assessment is recommended even in the absence of high fever. Bone aspiration for microbiological testing should be performed when indicated to prevent missed diagnosis of osteomyelitis caused by uncommon pathogens.

Host factors: diabetes and minor closed trauma

Long-term hyperglycemia represents the most critical host-related risk factor in this case. The patient's glycated hemoglobin (HbA1c) level was markedly elevated at 11.1%. A chronically hyperglycemic milieu promotes capsular polysaccharide synthesis in *Klebsiella variicola*, thereby enhancing its resistance to host phagocytosis¹. The patient sustained only a minor closed fall injury, with no evidence of skin breakdown; however, localized soft-tissue injury and microhematoma likely served as initial bacterial nidus sites, facilitating subsequent hematogenous dissemination to bone, liver, and the urinary tract. This pattern strongly supports trauma as a key precipitating factor for *Klebsiella variicola* infection⁵.

Based on the insights gained from this case, clinicians should recognize that even mild closed trauma in elderly patients with diabetes carries a non-negligible risk of deep-tissue and hematogenous infection. When localized swelling or pain develops following such injury, prompt assessment, including measurement of inflammatory biomarkers and targeted imaging, should be undertaken to enable early detection and management of severe infection.

Source control and prognosis

The cornerstone of successful management in this case lies in the early initiation of broad-spectrum antibiotics and complete drainage of all infected lesions. Empirical carbapenem therapy was commenced promptly, prior to receipt of culture results, and subsequently de-escalated in a timely manner upon clinical improvement, balancing antimicrobial efficacy with principles of antimicrobial stewardship. Drainage of multiple infectious foci in the bone marrow, liver, and thoracic cavity helped interrupt the inflammatory cascade and reverse septic shock. For deep-seated multifocal infection, antibiotics alone are insufficient; adequate source-control drainage is essential for clinical recovery.

Limitations

As a single-case report, this study has several limitations. Regarding the molecular characterization of the incomplete strain isolates in this study: no wire-drawing test or capsular typing was performed; whole-genome sequencing was not conducted, precluding the acquisition of data on virulence genes, sequence types (STs), and virulence-associated plasmids¹⁶. Furthermore, the functional roles of biofilm

formation and outer membrane vesicles were not assessed, limiting our ability to elucidate the molecular basis for its enhanced invasiveness. Future studies should include additional clinical cases and comprehensive mechanistic investigations to clarify the pathogenic mechanisms of *Klebsiella* isolates and to refine prevention and control strategies for high-risk populations.

Conclusion

This case extends the known disease spectrum of *K. variicola* to include post-traumatic osteomyelitis with synchronous hepatic abscess and urinary tract infection. It also underscores a diagnostic reality: *K. variicola* can behave like hypervirulent *K. pneumoniae*, yet remain hidden behind conventional identification. For clinicians, the key takeaway is to suspect members of the *K. pneumoniae* species complex in diabetic patients with deep-seated infections after even trivial trauma, to use mNGS for early species-level diagnosis, and to combine antibiotics with timely source control to improve outcomes.

Declarations

Competing interests

All authors declare that they have no competing interests.

Ethics approval and consent to participate

This retrospective case report was conducted in accordance with the Declaration of Helsinki. The study protocol was reviewed and approved by the Ethics Committee of Mianyang Central Hospital (approval number: pending). Written informed consent for clinical participation was obtained from the patient's legal guardian. All patient-identifying details have been removed from the manuscript to preserve confidentiality.

Consent for publication

Written informed consent for the publication of this case report and any accompanying images was obtained from the patient's legal guardian. A copy of the signed consent form is available for review by the Editor-in-Chief of this journal.

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Author Contribution

Gao SM: Conceptualization, Data curation, Writing-original draft, Writing-review & editing. Yao S: Data curation, Investigation. Ma F: Data curation, Investigation. Zhao WQ: Resources, Supervision. Luo YX: Resources, Supervision. Xu ZH: Supervision, Writing-review & editing. All authors read and approved the final version of the manuscript.

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Availability of data and materials

All data generated or analysed during this study are included in this published article.

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Figures

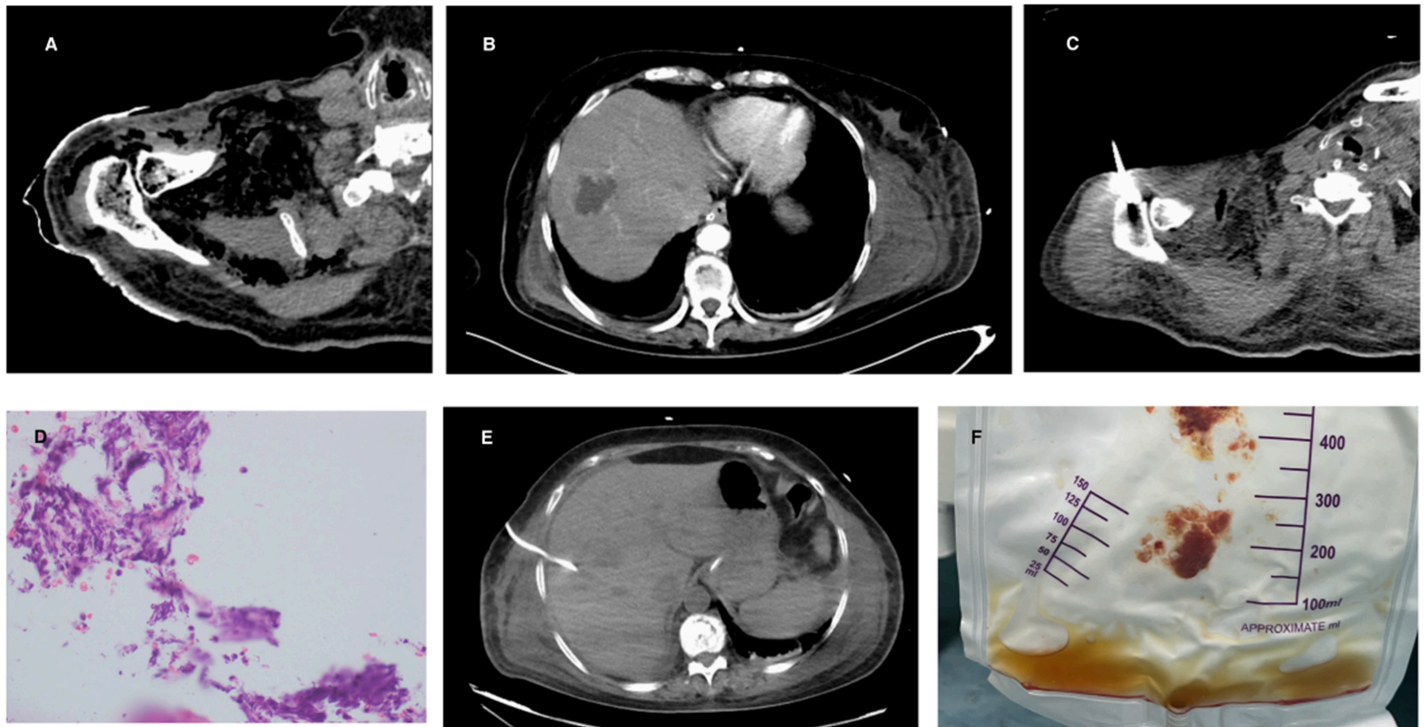


Figure 1

Imaging and histopathological findings. (A) CT of the shoulder joint: Soft-tissue swelling and pneumatocele in the right supraclavicular and axillary regions; pneumosinus within the medullary cavities of the clavicle and scapula. (B) CT of the chest and abdomen: A slightly hypoattenuating hepatic mass measuring approximately 3.4 cm x 3.1 cm in the right lobe of the liver. (C) CT-guided bone marrow biopsy of the acromion. (D) Bone marrow biopsy histopathology: Diffuse infiltration by abundant neutrophils. (E-F) Ultrasound-guided percutaneous drainage catheter placement for hepatic abscess; post-procedural CT and purulent drainage fluid specimen.

Supplementary Files

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- [Table1.Clinical timeline of the patient's hospital course.docx](#)