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**RESPONSIBLE EDITORS FOR THIS ISSUE**

Production Editor: *Si Zhao*; Production Department Director: *Xu Guo*; Editorial Office Director: *Jin-Lei 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**

Bao-Gan Peng, Jerzy Tadeusz Chudek, George Kontogeorgos, Maurizio Serati, Ja Hyeon Ku

**EDITORIAL BOARD MEMBERS**

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

**PUBLICATION DATE**

October 6, 2023

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**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>

## Intracranial infection and sepsis in infants caused by *Salmonella derby*: A case report

Jing-Lu Yu, Li-Li Jiang, Rong Dong, Si-Yu Liu

**Specialty type:** Medicine, research and experimental

**Provenance and peer review:** Unsolicited article; Externally peer reviewed.

**Peer-review model:** Single blind

**Peer-review report's scientific quality classification**

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

**P-Reviewer:** Kenzaka T, Japan;  
Oley MH, Indonesia

**Received:** July 30, 2023

**Peer-review started:** July 30, 2023

**First decision:** August 9, 2023

**Revised:** August 20, 2023

**Accepted:** September 6, 2023

**Article in press:** September 6, 2023

**Published online:** October 6, 2023



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### Abstract

#### BACKGROUND

*Salmonella derby* (*S. derby*) is a Gram-negative diplococcus that is common in the digestive tract. Infected patients generally experience symptoms such as fever and diarrhea. Mild cases are mostly self-healing gastroenteritis, and severe cases can cause fatal typhoid fever. Clinical cases are more common in children. The most common form of *S. derby* infection is self-healing gastroenteritis, in which, fever lasts for about 2 d and diarrhea for < 7 d. *S. derby* can often cause bacterial conjunctivitis, pneumonia, endocarditis, peritonitis and urethritis. However, intracranial infections in infants caused by *S. derby* are rare in clinical practice and have not been reported before in China.

#### CASE SUMMARY

A 4-mo-old female infant had recurrent fever for 2 wk, with a maximum body temperature of around 39.4°C. Treatment for infectious fever in a local hospital was ineffective, and she was admitted to our hospital. Before admission, there was one sudden convulsion, characterized by unclear consciousness, limb twitching, gaze in both eyes, and slight cyanosis on the face. Cerebrospinal fluid (CSF) culture was positive for Gram-negative bacilli, which conformed to *S. derby*. After treatment with meropenem and ceftriaxone antibiotics, the patient was discharged home in a clinically stable state after 4 wk of treatment.

#### CONCLUSION

We reported a rare case of *S. derby* cultured in CSF. *S. derby* enters the CSF through the blood-brain barrier, causing purulent meningitis. If not treated timeously, it can lead to serious, life-threatening infection.

**Key Words:** *Salmonella derby*; Infants; Cerebrospinal fluid; Case report

**Core Tip:** *Salmonella spp.* are common foodborne pathogens that causes various infections through contaminated food or water through the mouth. Among them, *Salmonella derby* is an important zoonotic pathogen, and healthy individuals can also be carriers, often causing symptoms such as sepsis and food poisoning. In rare cases, patients can develop bacterial encephalitis. Antimicrobial treatment should be given based on bacterial culture and antimicrobial susceptibility testing, and take into consideration any contraindications.

**Citation:** Yu JL, Jiang LL, Dong R, Liu SY. Intracranial infection and sepsis in infants caused by *Salmonella derby*: A case report. *World J Clin Cases* 2023; 11(28): 6961-6966

**URL:** <https://www.wjgnet.com/2307-8960/full/v11/i28/6961.htm>

**DOI:** <https://dx.doi.org/10.12998/wjcc.v11.i28.6961>

## INTRODUCTION

*Salmonella* can cause various infections through consumption of contaminated food or water, and infected patients generally experience symptoms such as fever and diarrhea. Mild cases are mostly self-healing gastroenteritis and severe cases can cause fatal typhoid fever. Clinical cases are more common in children[1-5]. The most common form of *Salmonella* infection is self-healing gastroenteritis, in which, fever lasts for about 2 d and diarrhea for < 7 d. The classification of *Salmonella* is mainly based on its antigenic structure. More than 2000 serotypes have been identified, and approximately 100 have been identified in China[6]. *Salmonella derby* (*S. derby*) in group B is an important zoonotic pathogen that can cause symptoms such as sepsis and food poisoning, posing a serious threat to human health[7]. In recent years, the isolation of *S. derby* has become most frequent in the pork production chain, and the carrier rate among healthy populations is also high[8].

## CASE PRESENTATION

### Chief complaints

A 4-mo-old baby girl had recurrent fever for > 2 wk, but anti-infective treatment was ineffective, so she was admitted to our hospital.

### History of present illness

The patient developed a fever without obvious cause 2 wk previously, with a maximum body temperature of 39.4°C and no chills or convulsions. She was treated with oral paracetamol to reduce the fever. Her temperature rose again after 3-4 h, and it fluctuated three or four times a day. She had been to another hospital several times and was diagnosed with infectious fever. Anti-infective treatment with oseltamivir granules and cefoperazone injection was ineffective. One hour before transfer to our hospital, she had a sudden convulsion, presenting as unclear consciousness (Glasgow Coma Scale score of 12 points), limb twitching, staring with both eyes, and slight cyanosis on the face.

### Personal and family history

The patient's personal and family history was unremarkable. She denied a history of hepatitis, tuberculosis and other infectious diseases, diabetes, cardiovascular and cerebrovascular disease, and had no family history of malignant tumors.

### Physical examination

A child with purulent meningitis and sepsis was admitted to our hospital on June 29, 2022. Physical examination showed: Unclear consciousness, body temperature 37.2°C, binocular gaze, bilateral pupils of equal size and approximately 3 mm in diameter, insensitivity to light, anterior fontanel about 1.5 cm × 1.5 cm, anterior fontanelle protrusion, anterior fontanel high tension, slightly pale complexion, thick breathing sounds in both lungs, without rales, high muscle tension in the limbs, neck resistance (convulsive state), lack of coordination in knee tendon reflexes, and positive bilateral Pap's sign. She had diarrhea, yellow-green loose stools five or six times a day, with mucus but no blood, acid or odor.

### Laboratory examinations

White blood cells  $16.8 \times 10^9/L$  (normal:  $3.5 \times 10^9$ - $9.5 \times 10^9/L$ ), percentage of neutrophils 71.5% (normal: 40.0%-75.0%), percentage of lymph nodes 19.5% (normal: 20.0%-50.0%), hemoglobin 98 g/L (normal: 115-150 g/L), platelets  $100 \times 10^9/L$  (normal:  $125 \times 10^9$ - $350 \times 10^9/L$ ). Rapid hypersensitivity C-reactive protein: 318.2 mg/L (normal: 0.0-8.0 mg/L). Blood gas analysis showed: pH 7.29 (normal: 7.35-7.45), oxygen partial pressure 24 mmHg (normal: 83-108 mmHg), carbon dioxide partial pressure 54 mmHg (normal: 35-45 mmHg), bicarbonate 26.0 mmol/L (normal: 21.0-28.0 mmol/L), potassium 4.7 mmol/L (normal: 3.5-5.3 mmol/L), sodium 133 mmol/L (normal: 137-147 mmol/L), glucose 6.8 mmol/L

(normal: 3.9–6.1 mmol/L), lactic acid 4.1 mmol/L (normal: 0.5–1.7 mmol/L), cerebrospinal fluid (CSF) examination showed white blood cell count of  $8000 \times 10^6/L$  (normal:  $0-20 \times 10^6/L$ ), mainly neutrophils. Pan's test was positive, with an increase in protein content of 4.45 g/L (normal: 0.15–0.45 g/L) and a decrease in sugar content of  $< 0.28$  mmol/L (normal: 2.5–4.4 mmol/L), which meets the diagnostic criteria for bacterial meningitis. CSF bacterial smear examination detected Gram-negative bacteria (Figure 1A). Blood and CSF culture were used to identify pathogenic bacteria. Blood, cerebrospinal fluid, and feces of the child were cultured at the same time, and the results showed Gram negative bacteria and negative oxidase, and positive contact enzyme. They grew well on blood agar and chocolate agar plates, with 1–2 mm, gray, round, moist and protruding colonies. The *Salmonella* Shigella culture medium was transparent with black  $H_2S$ -producing colonies in the center (Figure 1B). The bacteria were identified as *Salmonella* by microbial mass spectrometry. Further identification by *Salmonella* factor diagnostic serum revealed that the results were agglutinated with multivalent A to F group serum and O4, Hf, g, without the presence of H phase 2, and ultimately confirmed as B group Delphi *Salmonella*. Drug sensitivity test indicated sensitivity to carbapenems and third-generation cephalosporins. The pure culture was identified as *S. derby* by Vitek MS mass spectrometry. To obtain accurate identification, 16s RNA sequencing was performed. The results showed that the sequence was 99.85% consistent with the sequence of *S. derby*.

### Imaging examinations

Brain magnetic resonance imaging (MRI) showed abnormal signals in bilateral paraventricular, frontal and parietal lobes, which indicated subacute cerebral infarction. The space outside the brain widened, and a small amount of blood accumulated in the posterior horn of both ventricles (Figure 2).

## FINAL DIAGNOSIS

The final diagnosis was intracranial infection and sepsis caused by *S. derby*.

## TREATMENT

The patient was treated for 2 wk with meropenem 0.25 g q8h, which was ineffective. The treatment was changed to intravenous ceftriaxone 3 g for 2 wk, and the patient's condition improved.

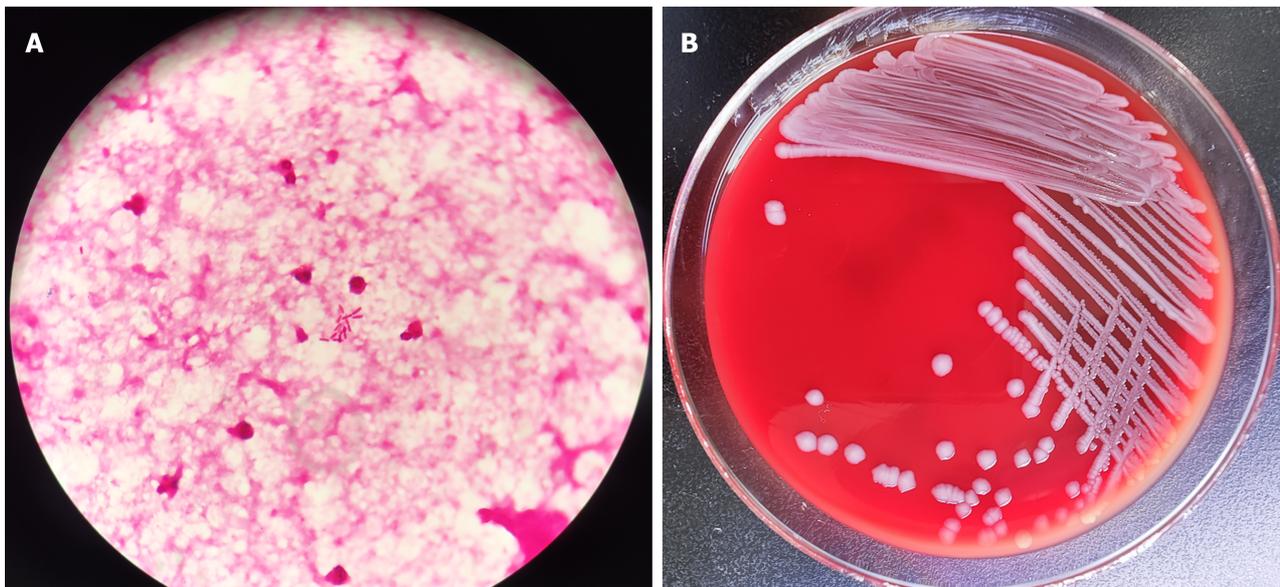
## OUTCOME AND FOLLOW-UP

After treatment, the patient had a clear mind, good spirits, no fever, rosy complexion, flat breathing, clear respiratory sounds in both lungs, no rales, consistent heart rhythm and no murmurs, no cough or nasal congestion, no rash, no convulsions, good breastfeeding, good sleep, and normal bowel movements. The abdomen was soft without bloating, the liver and spleen were not enlarged, bowel sounds were 5 times/ min, and there were no abnormal positive signs in the nervous system examination. Re-examination of head MRI showed improvement; CSF was clear and transparent, with negative culture; blood culture was negative and stool culture was negative twice; inflammatory indicators decreased; clinical symptoms disappeared; and anti-infective treatment was effective. The patient was discharged.

## DISCUSSION

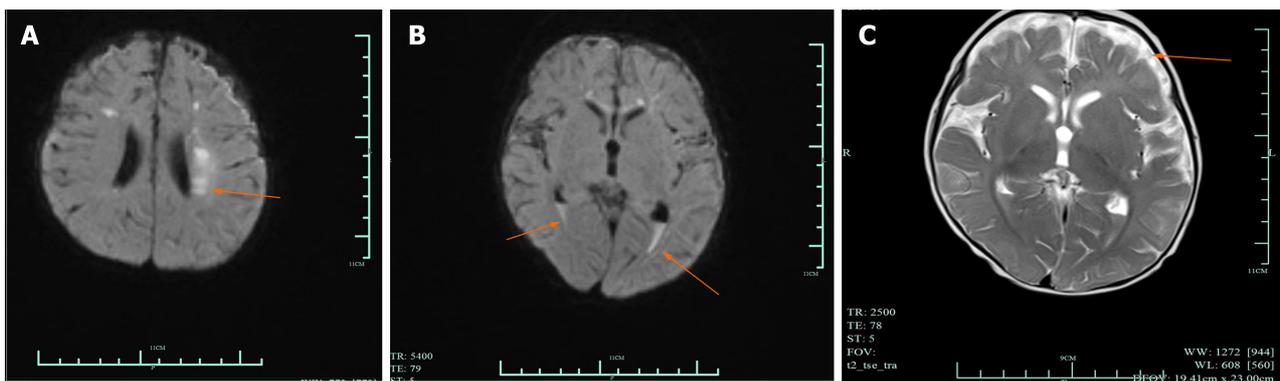
The clinical manifestations of human *Salmonella* infection are complex, which can be divided into asymptomatic and symptomatic infection[9]. According to symptom severity, it can be divided into typhoid fever, gastroenteritis, local suppurative infection, and sepsis types[10]. Nontyphoid *Salmonella* infection generally manifests as mild symptoms of self-limited diarrhea in healthy individuals, and rare bloodstream or focal infections may only occur in individuals with specific risk factors[11,12]. *Salmonella* can cause various infections, ranging from self-healing gastroenteritis to fatal typhoid fever[13]. Clinically, it is common in children, and in infants and young children, it can seriously affect their physical and mental health[14,15]. Therefore, the cultivation and isolation of *Salmonella* and identification of the species are important. Different specimens are taken according to different disease courses. Usually, blood is taken in the first to second weeks, feces or urine is taken in the second to third weeks, and vomit and residual food are taken for detection of acute enteritis. Blood is taken for culture in suspected sepsis. According to literature reports, the isolation rate of *Salmonella delbrueckii* in the pork production chain tends to be the highest, and the carrier rate is also among the highest in healthy populations[16].

Currently, there are only a few reports of *Salmonella* cultured from CSF. From 2001 to 2022, three cases of *Salmonella enteritidis*, two each of *Salmonella dublin* and *Salmonella newport*, and one each of *Salmonella essen*, *Salmonella para-typhi* B and *Salmonella typhimurium* were cultured in CSF samples[17–21]. There was no relevant report on *S. derby*, of which 9 cases were in infants and one was in an adult trauma patient[14]. The reason may be that the blood–brain barrier of infants is not perfect, *Salmonella enteric* infection induces sepsis, and the bacteria in the blood enter the CSF through the blood–brain barrier, causing purulent meningitis.



DOI: 10.12998/wjcc.v11.i28.6961 Copyright ©The Author(s) 2023.

**Figure 1 Smear examination and bacterial culture results of cerebrospinal fluid.** A: Gram staining of peritoneal dialysate specimens after centrifugation (1000 ×); B: Colony morphology on a blood agar plate at 35°C, 5% CO<sub>2</sub> and cultured for 48 h.



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**Figure 2 Head magnetic resonance imaging before treatment.** A: Head magnetic resonance imaging (MRI) were observed subacute cerebral infarction; B: MRI suggested hemocele in the posterior horn of bilateral ventricles; C: MRI revealed widening of extracerebral space. MRI: Magnetic resonance imaging.

This is the first case of *S. derby* cultured in the CSF of infants and young children in our hospital. The child lived in a remote rural areas with poor hygiene, mainly breastfeeding, and incomplete disinfection of hands or utensils may have caused infection. However, the initial route of infection still needs confirmation. Although drug sensitivity testing indicates that *S. derby* is sensitive to chloramphenicol and fluoroquinolones, the former is difficult to metabolize and eliminate in newborns, and the latter has an impact on the bone development of infants. The clinical use of antibiotics should be cautious. In this case, meropenem and ceftriaxone were selected for anti-infective treatment, with obvious effects and good prognosis. This report summarizes the clinical data of a case of *S. derby* infection to deepen clinicians' understanding of the intestinal and bloodstream infection in infants. Bacteria can cross the blood-brain barrier and cause intracranial infection. Clinical attention should be paid to the isolation and identification of pathogens, drug sensitivity and individual factors to select appropriate and effective drugs.

## CONCLUSION

We present an infant with intracranial infection and sepsis caused by *S. derby*. This infection is rare, and if not treated in a timely manner, it may become serious and even life-threatening, which should alert clinicians.

## FOOTNOTES

**Author contributions:** Yu JL and Jiang LL contributed to manuscript writing and editing, and data collection; Jiang LL and Dong R contributed to data analysis; Liu SY contributed to conceptualization and supervision; all authors have read and approved the final manuscript; Yu JL and Jiang LL contributed equally to this work.

**Informed consent statement:** Informed consent was obtained from the patient for publication of this report and any accompanying images.

**Conflict-of-interest statement:** The authors declare no conflict of interest.

**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).

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**Country/Territory of origin:** China

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**S-Editor:** Lin C

**L-Editor:** A

**P-Editor:** Cai YX

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