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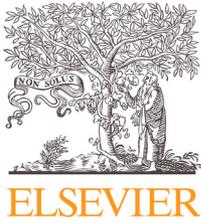
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### Recommended Citation

Ward, H. H., Lauber, P., Laubach, L., Fishbein, J., & Greenberg, M. R. (2021). Citrobacter koseri meningitis with cerebral edema and pneumocephalus in a neonate. *LVHN Scholarly Works*. Retrieved from <https://scholarlyworks.lvhn.org/research-historical-works/99>  
DOI: 10.1016/j.radcr.2020.12.039

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## Case Report

# Citrobacter koseri meningitis with cerebral edema and pneumocephalus in a neonate ☆☆☆

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## ARTICLE INFO

## Article history:

Received 22 October 2020

Revised 15 December 2020

Accepted 15 December 2020

Available online 22 December 2020

## Keywords:

Citrobacter koseri

Meningitis

Pneumocephalus

Encephalitis

Neonatal

## ABSTRACT

Sometimes the only indicator of a serious infection in a neonate is a fever. *Citrobacter koseri* (*C. koseri*) has been reported to cause neonatal brain abscesses in the setting of meningitis. Although rare, pneumocephalus, secondary to *C. koseri*, carries a very high mortality. A 17-day-old male presented to the emergency department with a fever, decreased oral intake, and lethargy. The patient developed pneumocephalus and cerebral edema and was diagnosed with *C. koseri* meningitis, leading to death. This case demonstrates the presentation of *C. koseri* meningitis with pneumocephalus and cerebral edema in a neonate presenting with fever.

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## Introduction

The presence of a fever, a rectal temperature greater than 38°C, may be the only indicator of a serious infection in a neonate [1,2]. Thus, it is considered standard of care to perform an extensive work-up upon emergency department (ED) arrival in febrile patients <60 days of age to assess for underlying infection. Pruitt et al. found that infants with bacterial meningitis

and bacteremia were more likely to experience adverse outcomes than patients with only bacteremia [1].

*Citrobacter koseri* (*C. Koseri*) is a facultative anaerobic, gram-negative bacillus that produces gas by catabolizing glucose and other carbohydrates and is a possible cause of meningitis within the first 2 months of life [3,4]. It is unclear whether neonates acquire the infection via vertical transmission or inoculation from environmental factors, however there might be a developmental protection obtained after the first few

\* Acknowledgments: The authors would like to acknowledge Jasdip Kaur, BS for her scholarly assistance with editing and formatting this Case Report.

☆☆ Competing Interests: None. The authors have no outside support information, conflicts or financial interest to disclose and this work has not been published elsewhere. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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<https://doi.org/10.1016/j.radcr.2020.12.039>

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months of life [3]. This is further evidenced by Alviedo et al., who found a lack of reported cases of *C. koseri* meningitis in infants over 2 months old [5].

*C. koseri* in most cases causes cerebral adhesions and abscesses [3,4]. Rare cases resulting in fatality have been reported of neonates acquiring meningitis from *C. koseri* and developing pneumocephalus and encephalitis [5,6].

Research suggests a possible predisposition of preterm infants to develop *C. koseri* meningitis, as approximately one-third of reported cases have occurred in infants with a gestational age of less than 36 weeks [5]. To our knowledge, this is the first case of *C. koseri* meningitis with cerebral edema and pneumocephalus in a previously healthy infant born nearly full term.

## Case Report

A 17-day-old male presented to the ED with decreased oral intake, lethargy, and fever for less than 1 day, with a rectal temperature of 38.3°C. The patient was born via cesarean delivery secondary to breech presentation at 37 weeks gestation. Family denied any known sick contacts, travel outside the country, and any changes to formula. Past medical history was only remarkable for a mildly elevated bilirubin, which was monitored and did not require phototherapy.

Review of systems was positive for fever and decreased activity, oral intake, and urinary output. The patient's triage vitals were: blood pressure 65/37, heart rate 210, temperature 39.2°C, respirations 52, weight 8lbs 6.4oz, and oxygen saturation 100% on room air. A septic work-up was initiated with laboratories and a chest x-ray. Lumbar puncture was delayed due to the mother's hesitancy.

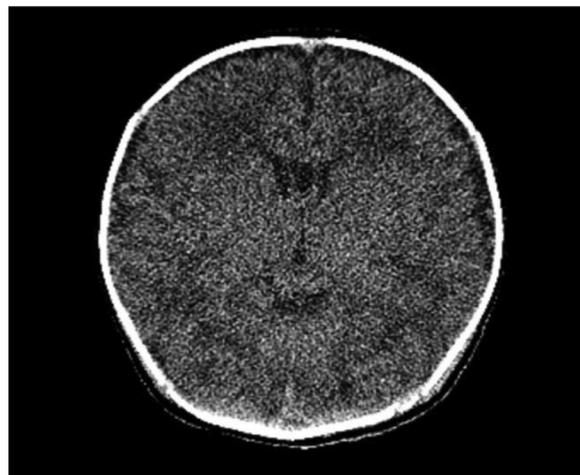
Within an hour of arrival, the patient became hypoxic, with an oxygen saturation of 76% on room air and frequent periods of apnea. Intubation was complicated by vomiting and he decompensated into cardiopulmonary arrest. After multiple failed attempts, 2 rounds of cardiopulmonary resuscitation, and administration of epinephrine, intubation was successful, with return of spontaneous circulation. Ampicillin was initiated and a head computerized tomography (CT) was ordered and performed while the patient was in the ED, but was unremarkable (Image 1).

The patient was admitted to the Pediatric Intensive Care Unit, where cefotaxime was initiated.

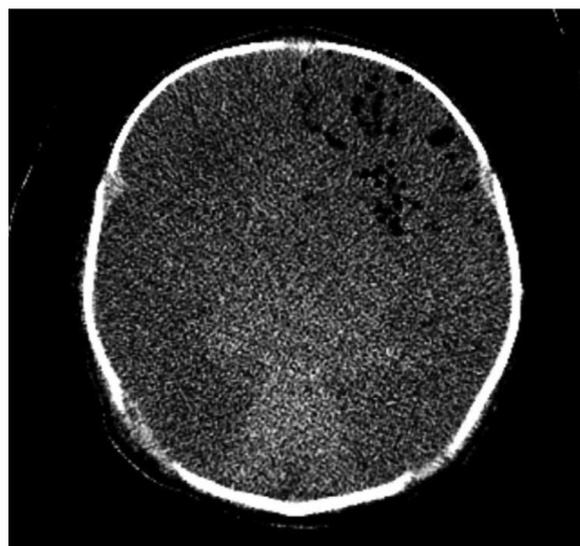
The following day, his lumbar puncture was positive for gram negative rods. The cerebral spinal fluid culture grew *C. koseri*. Ampicillin was stopped, and cefotaxime was continued.

After two days, he began demonstrating signs of herniation. A repeat head CT on hospital day 3 (Image 2) demonstrated diffuse loss of the gray-white matter junction within the supratentorial brain and basal ganglia, diffuse parenchymal edema with new and near complete effacement of the basilar cisterns, diffuse gas throughout the left frontal lobe, and questionable partial herniation of the cerebellar tonsils beneath the foramen magnum.

Neurologic examination showed no spontaneous movements, response to painful stimuli, pupillary response to light,



**Image 1 – Normal computed tomography head of patient performed during the ED assessment.**



**Image 2 – Repeat computed tomography head of patient on hospital day 3 demonstrating diffuse gas throughout the left frontal lobe, diffuse loss of gray-white matter differentiation, and diffuse parenchymal edema.**

or cough, gag, and corneal reflexes. An echoencephalography further confirmed diffuse cerebral edema.

Four days after the patient's presentation, brain death was confirmed and the decision was made the following morning to terminally extubate the patient. The coroner verified it was not a coroner's case, and the family requested no autopsy.

## Discussion

To our knowledge, this is the first reported case of *C. koseri* meningitis with cerebral edema and pneumocephalus in a previously healthy neonate born nearly full term. Previously

reported neonatal cases of *C. koseri* meningitis and pneumocephalus were in premature infants or those who have had medical complications prior to diagnosis [5,6]. Martínez-Lage et al. reported a case of a previously healthy 2-month old who was diagnosed with *C. koseri* meningitis, but without pneumocephalus on the CT scan [4]. Consistent with Pruitt et al.'s results, this case presented a neonate with bacterial meningitis and bacteremia that ended in death despite intervention [1].

Although the exact pathophysiology of how *C. koseri* contributes to such fatal outcomes is not understood, evidence suggests that it is a largely destructive process, which should be treated quickly and aggressively. Research found that when different strains of *C. diversus* (now *C. koseri*) were tested through multilocus enzyme electrophoresis, a 32-kDa outer membrane protein was expressed primarily on those obtained from the cerebral spinal fluid of infants with meningitis [7]. This suggests that this protein may play the role of a virulence factor.

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## Conclusion

This case serves to acknowledge the possible presentation of *C. koseri* meningitis with pneumocephalus and cerebral edema in a neonate presenting to the ED with fever. Further study is necessary to understand the bacteria's mechanism of infection in neonates in the hopes of preventing more fatal cases.

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## Declaration

No written consent has been obtained from the patients as there is no patient identifiable data included in this case report and the patient is deceased.

## REFERENCES

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- [1] Pruitt CM, Neuman MI, Shah SS, Shabanova V, Woll Christopher, Wang ME, et al. Factors associated with adverse outcomes among febrile young infants with invasive bacterial infections. *J Pediatr* 2019;204:177–82.
- [2] Ramgopal S, Janofsky S, Zuckerbraun NS, Ramilo O, Mahajan P, Kuppermann N, et al. Risk of serious bacterial infection in infants aged  $\leq 60$  days presenting to emergency departments with a history of fever only. *J Pediatr* 2019;204:191–5.
- [3] Doran Terence I. The role of *Citrobacter* in clinical disease of children: review. *Clin Infect Dis* 1999;28(2):384–94.
- [4] Martínez-Lage JF, Martínez-Lage AL, Almagro MJ, Bastida ME, Reyes S, Tellez C. *Citrobacter koseri* meningitis: a neurosurgical condition? *European J Paediatr Neurol* 2010;14(4):360–3.
- [5] Alviedo JN, Sood BG, Aranda JV, Becker C. Diffuse pneumocephalus in neonatal *Citrobacter* meningitis. *Pediatr* 2006;118(5):1576–9.
- [6] Pooboni SK, Mathur SK, Dux A, Hewertson J, Nichani S. Pneumocephalus in neonatal meningitis: diffuse, necrotizing meningo-encephalitis in *Citrobacter* meningitis presenting with pneumatosis oculi and pneumocephalus. *Pediatr Crit Care Med* 2004;5(4):393–5.
- [7] Li J, Musser JM, Beltran P, Kline MW, Selander RK. Genotypic heterogeneity of strains of *Citrobacter diversus* expressing a 32-kilodalton outer membrane protein associated with neonatal meningitis. *J Clin Microbiol* 1990;28(8):1760–5.