

Case Report

Diarrhea-associated pneumococcal meningitis with complicating hydrocephalus in a child in a resource-limited setting

Lubaba Shahrin^{1,2}, Mohammad Jobayer Chisti^{1,2}, Sayeeda Huq^{1,2}, M Munirul Islam^{1,2}, Shafiqul Alam Sarkar^{1,2}, Mahmuda Begum², Shukla Saha², Tahmeed Ahmed²

¹ Dhaka Hospital, International Centre for Diarrheal Disease Research, Dhaka, Bangladesh

² Nutrition and Clinical Services Division, International Centre for Diarrheal Disease Research, Dhaka, Bangladesh

Abstract

Introduction: *Streptococcus pneumoniae* is the most common and intimidating cause of childhood meningitis. Its delayed diagnosis may be associated with hyponatremia and hypernatremia with fatal outcome.

Case presentation: A previously healthy nine-month-old Bangladeshi female infant was diagnosed with diarrhea, pneumonia, and convulsion due to hypernatremia. Pneumonia was confirmed by respiratory distress and radiological findings. Routine cerebrospinal fluid study detected pneumococcal meningitis. Ampicillin, gentamicin, and dexamethasone were promptly started. On day three of hospitalization, convulsion re-appeared with worsening of consciousness level. Antibiotics were switched to ceftriaxone and vancomycin, although ultrasonography of the brain revealed no abnormality. Contrast-enhanced computed tomography scan of the head was performed and revealed dilated ventricles with diffused enhancement of meninges and basal cisterns, demonstrating meningitis with ventriculomegaly. Ceftriaxone was replaced by meropenem to control fever. Magnetic resonance imaging (MRI) of the brain confirmed the progression of hydrocephalus. An emergency ventriculo-peritoneal (VP) shunt operation was performed with continuation of antibiotics for 21 days. After three months, follow-up MRI showed reduction of ventricular size with functioning VP shunt *in situ* with no neurological deficits.

Conclusions: Childhood pneumococcal meningitis may be associated with diarrhea, pneumonia, and other related complication. Appropriate antibiotic therapy alone may not be sufficient to avert complications. Communicating hydrocephalus is potentially an ominous ramification of meningitis even when the ultrasonography result is normal. Rapid diagnosis is imperative to attain good outcome. Evidence advocates further research into the risk factors of meningitis in diarrheal children that may help in early diagnosis and management to reduce meningitis-related fatal outcome.

Key words: Pneumococcal meningitis; diarrhoea, communicating hydrocephalus; hypernatremia; VP shunt.

J Infect Dev Ctries 2016; 10(8):888-891. doi:10.3855/jidc.7921

(Received 14 November 2015– Accepted 29 April 2016)

Copyright © 2016 Shahrin *et al.* This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Meningitis due to *Streptococcus pneumoniae* is a common and potentially life-threatening infection in young children [1]. Worldwide, the estimated proportion of deaths in children due to pneumococcal meningitis is 100,000–500,000 each year [2]. The morbidity (20%–30%) and case fatality (10%) rates have changed after the introduction of vaccines over the last 10 years [3]. The mortality of untreated cases approaches 100%; even with optimum treatment, significant mortality and morbidity might occur [3]. In survivors, neurological sequelae are relatively common, even after appropriate antibiotic therapy [4]. Moreover, in recent years there has been increased frequency of *Streptococcus pneumoniae* not susceptible to penicillin and third-generation cephalosporin [5].

The clinical presentations of pneumococcal meningitis are very often diverse, resulting in delayed

or missed diagnosis [6]. In fact, in a high diarrhea burden setting, the clinical presentations of meningitis may often get missed due to other associated conditions such as electrolyte disorders and pneumonia [7]. On the other hand, studies suggest that some co-morbid conditions may increase chance of developing invasive pneumococcal disease such as meningitis in developing countries [7,8]. Some review articles focus on the wide spectrum of clinically relevant infectious diseases that do not primarily affect the gastrointestinal tract, but in which diarrhea is common [9,10]. Yet it is unclear whether the diarrhea is an initial symptom or whether it developed during the course of the disease. Diarrhea-associated causes of convulsion (hypernatremia, hyponatremia, sepsis) have been reported earlier [11,12], but no report was found on co-existing diarrhea and pneumococcal meningitis.

We describe a clinical case of diarrhea with pneumococcal meningitis with complications even after proper antibiotic treatment.

Case presentation

A nine-month-old previously healthy female baby presented at Dhaka Hospital of the International Centre for Diarrheal Disease Research, Bangladesh with three days of yellow watery stool, vomiting, and high-grade intermittent fever. She manifested generalized convulsion on the way to the hospital. During admission, respiratory distress was evident in the form of lower chest wall indrawing and grunting respiration. At home, she was fed oral rehydration solution for diarrhea, which was improperly prepared in a concentrated manner (instead of 500 mL, dissolved in 250 mL × 5 sachets) and seemed to be large in quantity compared to stool volume. Physical examination revealed a febrile, obtunded child with exaggerated motor reflexes. Otoloscopic finding as well as throat examination were normal. No neurological deficit or papilledema was observed. Laboratory tests showed leucopenia (2,460/mm³; normal range 4–11,000/mm³) and increased serum sodium (158 mmol/L; normal range 135–145 mmol/L). The cerebrospinal fluid (CSF) was turbid with high protein (18.47 g/L; normal 0.15–0.45 g/L), low glucose (0.6 mmol/L; normal 3.33–4.44 mmol/L), and pleocytosis (white cell 16,000/mm³ polymorphs 98%). Corresponding blood glucose was normal.

For symptomatic hypernatremia, slow correction was started with oral rehydration salt through a nasogastric tube by a metered infusion pump. Severe pneumonia was treated with intravenous (IV) ampicillin and gentamicin. *Streptococcus pneumoniae* was isolated from blood and CSF culture. Empiric IV dexamethasone was started to prevent meningitis sequelae. On the following day, serum sodium became normal (143 mmol/L), but fever and poor consciousness remained unchanged. Suddenly, three days after hospitalization, convulsion recurred and the patient fell into a coma. Immediate ultrasonography of the brain showed no abnormality, though antibiotics were switched to IV ceftriaxone and vancomycin according to the antibiogram (Table 1). A contrast-enhanced computed tomography (CT) scan of the head was performed, which revealed dilated ventricles with diffuse enhancement of meninges and basal cisterns, indicating meningitis complicating ventriculomegaly with communicating hydrocephalus with normal parenchyma. For persistent fever, surgical intervention was delayed so that IV ceftriaxone could be switched to

meropenem. Within three days, fever responded, consciousness improved, and severe pneumonia resolved. Magnetic resonance imaging (MRI) of the brain was performed and revealed moderate hydrocephalus with meningitis sequelae (Figure 1). Developmental assessment was performed and revealed gross motor and cognitive delay. Physiotherapy and psychosocial stimulation was prescribed. After clinical stability, the patient was transferred to the National Institute of Neurosciences and Hospital for ventriculo-peritoneal (VP) shunt operation.

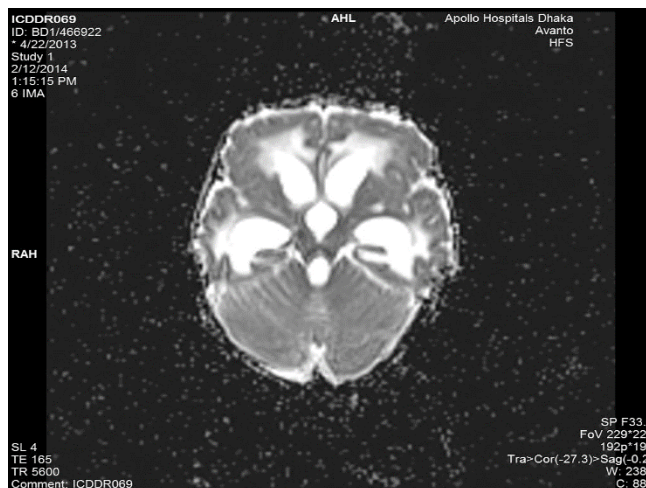
At follow-up three months later, the child was in good clinical condition. Repeated developmental assessment revealed improvement of motor function. Repeated MRI revealed residual mild hydrocephalus with VP shunt *in situ*. Her vision and hearing was apparently intact, and the family was advised to attend follow-ups every six months.

Table 1. *Streptococcus pneumoniae* isolated patterns from blood and cerebrospinal fluid (CSF).

Isolation from blood		Isolation from CSF	
Antibiotics	Sensitivity pattern	Antibiotics	Sensitivity pattern
Ampicillin	S	Ampicillin	S
Cotrimoxazole	R	Cotrimoxazole	R
Penicillin G	S	Penicillin G	S
Erythromycin	R	Erythromycin	R
Oxacillin	S	Oxacillin	S
Ceftriaxone	S	Ceftriaxone	S
Azithromycin	S	Azithromycin	S
Cefixime	S	Cefixime	S
Levofloxacin	S	Levofloxacin	S

S: sensitive; R: resistant; Legend: Antibiogram of *Streptococcus pneumoniae* in blood and cerebrospinal fluid (CSF).

Figure 1. Magnetic resonance imaging of brain T2w image (axial) without contrast showed dilated all 4 ventricles.



Consent

Written informed consent was obtained from the patient's legal guardian for publication of this case report and accompanying images.

Discussion

The clinical presentations of pneumococcal meningitis are variable and nonspecific, and no single sign is pathognomonic [13]. Most children initially present fever and signs of meningeal inflammation [3], which often proceed with upper respiratory tract infection symptoms. In infants, the clinical manifestations may include lethargy, respiratory distress, poor feeding, vomiting, seizures, and/or bulging fontanel [6]. One study demonstrated diarrhea as one of the most common presentations in children under six months of age [14], though epidemiological studies are lacking to strengthen the association in a high diarrhea burden country like Bangladesh.

According to the literature, many other causes of convulsion prevail in children with diarrhea, which can mask meningitis diagnosis [15-17]. CSF examination should therefore be encouraged in children presenting with convulsion, independent of other attributable causes (*e.g.*, hypernatremia [12] or hypoglycemia). In our case report, we observed mild hypernatremia values which are not usually linked to convulsion manifestation. Moreover, the drop of serum sodium was within the normal value, which is not as deep as it is usually expected to be in order to be associated with convulsion [18].

Streptococcus pneumoniae was isolated from the blood and CSF of our patient, and was sensitive to penicillin and cephalosporin. One study demonstrated that *Streptococcus pneumoniae* was isolated from blood and CSF at 80% and 88%, respectively, and that almost all isolates were sensitive to penicillin [14]. Among the sequelae of meningitis, hydrocephalus is estimated to occur in 3%–10% in children [5,19]. No significant differences were found between the groups treated with and without dexamethasone [20]. Moreover, there is no consensus as to which radio imaging study should be performed to evaluate sequelae in resource-limited settings.

Because of the lack of typical presentation, the diagnosis of hydrocephalus in such cases may be delayed and even missed. When treating any child with meningitis and persisting neurological sequelae, clinicians must maintain a strong suspicion despite the administration of appropriate antibiotic therapy. The available diagnostic tools including brain ultrasonography, CT head scan, and MRI brain scan. Of

these, CT is the most useful study when sequelae are suspected [13]. Better information can be obtained with the addition of a post-contrast CT scan. A CT scan can help to distinguish obstructive (non-communicating) from absorptive (communicating) hydrocephalus. Communicating hydrocephalus is classically distinguished by symmetric dilatation of all four ventricles, whereas non-communicating hydrocephalus typically results in dilated lateral and third ventricles and normal-sized fourth ventricle due to stenosis of the aqueduct. This distinction informs treatment decisions about shunting versus third ventriculostomy.

Without surgical intervention, hydrocephalus progresses rapidly to neurological deterioration [14]. The choice of surgical drainage for communicating hydrocephalus is a mechanical shunt system to allow the CSF flow from the ventricles to the peritoneum or the systemic circulation. However, post-operative shunt infection is a common life-threatening complication, occurring in approximately 5%–15% of procedures [21], which can be lessened by perioperative prophylactic antibiotics by approximately 50% [22].

Conclusions

Pneumococcal meningitis in children sometimes has a poor prognosis despite prompt diagnosis and therapy. Hydrocephalus is a common sequelae, even with appropriate treatment. In our case, even though meningitis was incidentally diagnosed and complicated with sequelae-like hydrocephalus, the prognosis was good due to timely intervention and consequently achieved a good neurodevelopmental outcome at the three-month follow-up. Nonetheless, more epidemiological research should be undertaken for early identification of risk factors of meningitis in diarrhea-prone settings.

Acknowledgements

We sincerely acknowledge the clinicians and nurses who were actively involved in patient care, along with other laboratory personnel, for their continuous support.

Authors' contribution

LS contributed to manuscript writing and medical assistance to the patient. MJC supervised the patient's treatment and manuscript writing. MMI supervised the neuroimaging examination and review of manuscript. SAS provided assistance in neurological examination and patient treatment. SH assisted in the clinical follow-up of the patient. SH and MB provided clinical follow-up and collected medical information. TA supervised the manuscript writing and literature review.

References

- Chávez-Bueno S, McCracken Jr GH (2005) Bacterial meningitis in children. *Pediatr Clin North Am* 52: 795-810.
- Greenwood B (1999) The epidemiology of pneumococcal infection in children in the developing world. *Philos Trans R Soc Lond B Biol Sci* 354: 777-785.
- Kim KS (2010) Acute bacterial meningitis in infants and children. *Lancet Infect Dis* 10: 32-42.
- O'Brien KL, Wolfson LJ, Watt JP, Henkle E, Deloria-Knoll M, McCall N, Lee E, Mulholland K, Levine OS, Cherian T; Hib and Pneumococcal Global Burden of Disease Study Team (2009) Burden of disease caused by *Streptococcus pneumoniae* in children younger than 5 years: global estimates. *Lancet* 374: 893-902.
- Arditi M, Mason EO, Bradley JS, Tan TQ, Barson WJ, Schutze GE, Wald ER, Givner LB, Kim KS, Yogeve R, Kaplan SL (1998) Three-year multicenter surveillance of pneumococcal meningitis in children: clinical characteristics, and outcome related to penicillin susceptibility and dexamethasone use. *Pediatrics* 102: 1087-1097.
- Klein JO, Feigin RD, McCracken GH, Jr (1986) Report of the Task Force on Diagnosis and Management of Meningitis. *Pediatrics* 78: 959-982.
- Hjuler T, Wohlfahrt J, Simonsen J, Kaltoft MS, Koch A, Kamper-Jørgensen M, Biggar RJ, Melbye M (2007) Perinatal and crowding-related risk factors for invasive pneumococcal disease in infants and young children: a population-based case-control study. *Clin Infect Dis* 44: 1051-1056.
- Sachdev H, Kumar S, Singh K, Satyanarayana L, Puri RK (1991) Risk factors for fatal diarrhea in hospitalized children in India. *Pediatr Gastroenterol Nutr* 12: 76-81.
- Reisinger EC, Fritzsche C, Krause R, Krejs GJ (2005) Diarrhea caused by primarily non-gastrointestinal infections. *Nat Clin Pract Gastroenterol Hepatol* 2: 216-222.
- O'dempsey TJ, McArdle TF, Lloyd-Evans N, Baldeh I, Laurence BE, Secka O, Greenwood BM (1994) Importance of enteric bacteria as a cause of pneumonia, meningitis and septicemia among children in a rural community in The Gambia, West Africa. *Pediatr Infect Dis J* 13: 122-127.
- Samadi AR, Wahed MA, Islam MR, Ahmed SM (1983) Consequences of hyponatraemia and hypernatraemia in children with acute diarrhoea in Bangladesh. *Br Med J (Clin Res Ed)* 286: 671.
- Chisti MJ, Pietroni MA, Alom MS, Smith JH (2012) Use of Only Oral Rehydration Salt Solution for Successful Management of a Young Infant with Serum Sodium of 201 mmol/L in an Urban Diarrhoeal Diseases Hospital, Bangladesh. *J Health Popul Nutr* 30: 371.
- Feigin RD, McCracken JR GH, Klein JO (1992) Diagnosis and management of meningitis. *Pediatr Infect Dis J* 11: 785.
- Kirkpatrick B, Reeves D, Mac Gowan A (1994) A review of the clinical presentation, laboratory features, antimicrobial therapy and outcome of 77 episodes of pneumococcal meningitis occurring in children and adults. *J Infect* 29: 171-182.
- Skinner AL, Moll FC (1956) Hypernatremia accompanying infant diarrhea. *Arch Pediatr Adolesc Med* 92: 562.
- Bruck E, Abal G, Aceto Jr T (1968) Pathogenesis and pathophysiology of hypertonic dehydration with diarrhea: a clinical study of 59 infants with observations of respiratory and renal water metabolism. *Arch Pediatr Adolesc Med* 115: 122.
- Robertson G, Carrhill M, Hatherill M, Waggle Z, Reynolds L, Argent A (2007) Relationship between fluid management, changes in serum sodium and outcome in hypernatraemia associated with gastroenteritis. *J Paediatr Child Health* 43: 291-296.
- Adroguá HJ, Madias NE (2000) Hypernatremia. *N Engl J Med* 342: 1493-1499.
- Laxer RM, Marks MI (1977) Pneumococcal meningitis in children. *Arch Pediatr Adolesc Med* 131: 850.
- Kennedy WA, Hoyt MJ, McCracken GH (1991) The role of corticosteroid therapy in children with pneumococcal meningitis. *Am J Dis Child* 145: 1374-1378.
- Chumas P, Tyagi A, Livingston J (2001) Hydrocephalus—what's new? *Arch Dis Child Fetal Neonatal Ed* 85: F149-F154.
- Ratilal B, Costa J, Sampaio C (2006) Antibiotic prophylaxis for surgical introduction of intracranial ventricular shunts. *Cochrane Database Syst Rev* 3: CD005365.

Corresponding author

Lubaba Shahrin
 Dhaka Hospital
 Nutrition and Clinical Services Division
 International Centre for Diarrheal Disease Research, Bangladesh
 68, Shaheed Tajuddin Ahmed Sarani
 Mohakhali, Dhaka 1212, Bangladesh
 Phone: +880-2-9827104; +8801754598328
 Fax: +880-2-9827104
 Email: lubabashahrin@icddr.org

Conflict of interests: No conflict of interests is declared.