

Impact of Reduced-Duration Antibiotic Therapy on Treatment Cost and Hospital Stay in Infantile Bacterial Meningitis

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ABSTRACT

Background: Bacterial meningitis poses a significant health threat worldwide, particularly in developing nations. While a course of antibiotics lasting 10–21 days is advised, extending treatment offers no evident advantages and may lead to higher expenses, longer hospital stays, and increased antimicrobial resistance. Shorter courses seem to be safe in straightforward situations, but data regarding infants is scarce. This study assesses the effects of reduced antibiotic duration on results, length of hospital stays, and expenses. **Methods & Materials:** This randomized six-month study conducted in a NICU in Bangladesh involved 126 infants with uncomplicated bacterial meningitis, comparing reduced-duration antibiotics to standard-duration antibiotics while providing similar supportive care. Clinical, laboratory, outcome, cost, and follow-up information were gathered and examined ($p < 0.05$), with ethical clearance and parental consent secured. **Results:** Among 126 infants, both groups were statistically alike at the beginning. No major differences were observed in clinical recovery or CSF parameters ($p > 0.05$). Nonetheless, the incidence of sepsis was markedly greater in the standard-duration group (11.1% vs 1.6%, $p = 0.028$). Shortened therapy duration notably lowered hospital stay (8.92 vs 15.74 days, $p < 0.001$) and expenses (18,450 vs 32,780 BDT, $p < 0.001$), showing no significant differences in mortality or follow-up outcomes, demonstrating comparable effectiveness with improved financial results. **Conclusion:** Shortened antibiotic treatment for uncomplicated infantile bacterial meningitis proved to be as effective as standard therapy, yielding similar outcomes but resulting in a significantly shorter hospital stay and reduced costs, without any

increase in mortality or complications, thereby presenting a safe and economical choice in specific instances.

Keywords: Antibiotic Therapy, Treatment Cost, Hospital Stay, Infantile Bacterial Meningitis.

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INTRODUCTION

Bacterial meningitis (BM) continues to be a significant global health issue, with approximately 90% of cases occurring beyond the neonatal stage stemming from three primary bacteria: Hib (Haemophilus influenzae type b), *S. pneumoniae* (Streptococcus pneumoniae), and *N. meningitidis* (Neisseria meningitidis) [1]. Neonatal meningitis is often underreported in developed nations (~0.3/1000), having a mortality rate of 10–15%, whereas in developing countries the incidence is higher (0.8–6.1/1000) and mortality rates are significantly elevated (40–58%) [2,3]. In infants, recognizing bacterial meningitis early is challenging as symptoms frequently lack specificity (fever, irritability, poor feeding, lethargy, and occasionally seizures), potentially delaying diagnosis and exacerbating outcomes. CSF analysis is the standard benchmark, but previous antibiotics might impair culture precision. Consequently, empirical broad-spectrum IV antibiotics are administered right away when meningitis is suspected [4,5]. The ideal

length of antibiotic treatment remains a topic of discussion. Present guidelines suggest 10–21 days of intravenous antibiotics based on the organism and response: 10–14 days for Streptococcus pneumoniae and Hib, and a minimum of 21 days for Gram-negative infections [6]. Data regarding the duration of antibiotics in young infants is scarce, primarily relying on observational studies and expert insights, lacking robust randomized trials. Extended treatment has not definitively demonstrated improved results, but might lead to longer hospital stays, higher expenses, and greater chances of negative effects [5,7]. The length of antibiotic treatment is closely linked to antimicrobial stewardship. Overuse contributes to antimicrobial resistance, a significant worldwide health issue. Shorter evidence-based treatment regimens might lessen antibiotic exposure without affecting results, but it is crucial to maintain a careful balance to prevent undertreatment [8,9]. A meta-analysis revealed no outcome differences between short (4–7 days) and longer (7–14 days) antibiotic regimens for

pediatric meningitis, but shorter treatment decreased hospital length of stay by approximately 2 days, with sparse data on young infants [10]. Restricted neonatal data indicates that shorter durations of antibiotic treatment might be safe. A study comparing 10 days to 14 days revealed no rise in relapse or failure with the shorter treatment and demonstrated shorter hospital stays, suggesting that extended therapy might not be required for stable neonates [11]. Another multicenter investigation involving neonates revealed that antibiotic treatment lasting over 21 days did not enhance survival or neurological outcomes, suggesting that extended therapy provides no significant advantage in uncomplicated situations [12]. A multicounty study, including Bangladesh, showed no difference in relapse or failure between 5-day and 10-day ceftriaxone treatment, indicating that shorter durations may be safe for stable children [13]. Neonatal sepsis and meningitis are being reported more frequently in tertiary hospitals in Bangladesh. Research conducted at

Chittagong Medical College Hospital revealed that numerous septic neonates later developed meningitis, leading to prolonged hospital admissions and extended courses of antibiotic therapy^[14]. In Bangladesh, the majority of research on bacterial meningitis in infants concentrates on causes and clinical results, with scarce evidence regarding the ideal duration of antibiotic treatment. Extended therapy is often employed, yet there is a deficiency of well-structured studies evaluating the effects of shorter antibiotic treatment on hospitalization duration and expenses. This study seeks to assess the impact of reduced antibiotic duration on expenses, length of hospital stays, and clinical results in infantile bacterial meningitis.

METHODS & MATERIALS

Study Design and Setting

This was a randomized comparative clinical study conducted in the infant ward of the Neonatal Intensive Care Unit (NICU) at Dhaka Shishu (Children) Hospital (DSH), Bangladesh. The study was carried out over a period of six months from October 2025 to March 2026.

Study Population

The study included 126 infants aged 0–2 months diagnosed with uncomplicated bacterial meningitis. The participants were equally allocated into two groups: Group A (reduced-duration antibiotic therapy, n=63) and Group B (standard-duration therapy, n=63).

Eligibility Criteria

Infants aged up to two months with clinically and laboratory-confirmed uncomplicated bacterial meningitis who were hemodynamically stable at admission were included in the study. Infants with complicated meningitis, including hydrocephalus, brain abscess, or severe neurological impairment at presentation, were excluded. Additional exclusion criteria included prematurity with major congenital anomalies, immunodeficiency disorders, and prior antibiotic therapy exceeding 48 hours before admission.

Intervention

Patients in Group A received reduced-duration empirical antibiotic therapy, while those in Group B received standard-duration therapy according to institutional protocol. Both groups received identical supportive management, including oxygen therapy, anticonvulsants, antipyretics, and fluid and electrolyte correction as required.

Data Collection Procedure

Data were collected prospectively using a structured case record form. At admission, detailed demographic and clinical information was recorded, including age, sex, and presenting symptoms such as fever, convulsion, vomiting, lethargy, feeding intolerance, and respiratory distress. Baseline clinical examination findings were also documented.

Laboratory and Microbiological Assessment

Blood and cerebrospinal fluid (CSF) samples were collected under aseptic conditions. CSF analysis included cell count, protein level, and glucose measurement. Microbiological evaluation included CSF and blood culture as well as Gram staining to identify causative organisms.

Outcome Assessment

Patients were closely monitored throughout hospitalization. Clinical outcomes included time to fever resolution, time to convulsion control, duration of oxygen therapy, and total length of hospital stay. In-hospital complications such as sepsis, mortality, and hydrocephalus were also recorded.

Cost Assessment

Total treatment cost for each patient was calculated based on hospital stay, medication expenses, laboratory investigations, and supportive care costs.

Follow-up Assessment

After discharge, patients were followed up to evaluate long-term outcomes, including seizure disorder, hearing impairment, and developmental delay.

Statistical Analysis

Data were analyzed using appropriate statistical methods. Continuous variables were expressed as mean ± standard

deviation and compared using independent samples t-test. Categorical variables were analyzed using Fisher’s exact test due to small expected cell counts. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study received approval from the Institutional Ethics Committee of Dhaka Shishu (Children) Hospital. Informed written consent was obtained from the parents or legal guardians of all enrolled infants prior to participation. Confidentiality of patient information was strictly maintained throughout the study period. Participation was voluntary, and guardians were informed that they could withdraw their child at any time without any impact on the standard of care. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

This study included 126 infants with uncomplicated bacterial meningitis, divided into Group A (reduced-duration antibiotic therapy, n=63) and Group B (standard-duration therapy, n=63). Both groups were comparable in baseline demographic characteristics. All infants in both groups presented with fever and convulsions.

Baseline Clinical Characteristics

Table I shows that the baseline demographic and clinical characteristics were comparable between Group A and Group B, indicating good homogeneity at enrollment. There was no statistically significant difference in mean age (1.21±0.48 vs 1.05±0.51 months, p=0.118) or sex distribution (p=0.721) between the two groups. Similarly, all major presenting clinical features—including fever, convulsions, vomiting, feeding intolerance, lethargy, and respiratory distress—were evenly distributed across both groups, with no significant differences observed (p>0.05 for all variables). This confirms that both groups had a similar disease profile at baseline.

Table I

Baseline characteristics of study population (n=126).

Variables	Group A (n=63), n (%)	Group B (n=63), n (%)	p-value
Age (months) mean ± SD	1.21 ± 0.48	1.05 ± 0.51	0.118
Sex (M/F)	38/25 (60.3/39.7)	36/27 (57.1/42.9)	0.721
Fever	63 (100)	63 (100)	1.000
Convulsion	63 (100)	63 (100)	1.000
Vomiting	56 (88.9)	53 (84.1)	0.432
Feeding intolerance	51 (81.0)	55 (87.3)	0.341
Lethargy	60 (95.2)	58 (92.1)	0.498
Respiratory distress	24 (38.1)	20 (31.7)	0.453

Chi-square test for categorical variables; Independent t-test for continuous variable. *Statistically significant (p < 0.05).

Microbiological Profile

Table II shows most pathogens showed no statistically significant difference between the groups ($p>0.05$), *Acinetobacter* spp. was

significantly more frequent in Group B compared to Group A (9.5% vs 1.6%, $p=0.048$). Other organisms, including *E. coli*, *Staphylococcus aureus*, and

Pseudomonas spp., showed no significant between-group differences.

Table II
Organisms isolated in blood/CSF cultures (n=126).

Organism	Group A n (%)	Group B n (%)	p-value
<i>Klebsiella pneumoniae</i>	3 (4.8)	7 (11.1)	0.173
<i>E. coli</i>	2 (3.2)	4 (6.3)	0.405
<i>Staphylococcus aureus</i>	1 (1.6)	0 (0.0)	0.315
<i>Pseudomonas</i> spp.	0 (0.0)	3 (4.8)	0.078
<i>Acinetobacter</i> spp.	1 (1.6)	6 (9.5)	0.048*

Fisher’s exact test was used for comparison of categorical variables due to small expected cell counts; $p < 0.05$ was considered statistically significant.

CSF Biochemical and Cytological Changes

Table III presents serial CSF analysis showed marked improvement in both groups from day 1 to day 7. There was a substantial reduction in CSF cell count and

protein levels, while CSF glucose showed gradual normalization in both groups. However, no statistically significant differences were observed between Group A and Group B in CSF parameters at day 7.

Table III
Comparison of CSF parameters (n=126).

CSF parameters	Group A	Group B	p-value
Cell count day 1 (mean±SD)	242.6 ± 228.4	289.7 ± 241.3	0.238
Cell count day 7	12.4 ± 9.1	13.1 ± 10.2	0.402
Protein day 1	218.5 ± 132.6	205.3 ± 118.9	0.521
Protein day 7	98.2 ± 64.3	110.6 ± 150.8	0.447
Sugar day 1	31.8 ± 10.2	29.4 ± 11.6	0.214
Sugar day 7	35.2 ± 7.4	32.1 ± 10.8	0.098

Independent t-test for continuous variable; *Statistically significant ($p < 0.05$).

Clinical Outcomes

Table IV shows that there were no statistically significant differences between the two groups in early clinical recovery

parameters. The time to fever resolution, convulsion control, and duration of oxygen therapy were comparable between Group A and Group B ($p>0.05$ for all). This indicates

that reduced-duration antibiotic therapy achieved similar early clinical outcomes compared to standard-duration therapy.

Table IV
Clinical outcomes between Study Groups (n=126).

Outcome	Group A	Group B	p-value
Fever resolution (days)	2.61 ± 0.71	2.68 ± 0.73	0.578
Convulsion control (days)	2.43 ± 0.42	2.39 ± 0.45	0.612
Oxygen therapy duration (days)	1.81 ± 0.24	1.79 ± 0.27	0.731

Independent t-test; *Statistically significant ($p < 0.05$).

Adverse Events

Table V shows regarding adverse outcomes during hospitalization, sepsis was

significantly more frequent in Group B compared to Group A (11.1% vs 1.6%, $p=0.028$). Although mortality was higher in

Group B (4.8% vs 1.6%), the difference was not statistically significant ($p=0.307$).

Table V
Adverse Events between Study Groups (n=126).

Adverse Events	Group A (Reduced-duration, n=63), n (%)	Group B (Standard-duration, n=63), n (%)	p-value
Sepsis	1 (1.6)	7 (11.1)	0.028*
Death	1 (1.6)	3 (4.8)	0.307
Hydrocephalus	0 (0.0)	2 (3.2)	0.154

Fisher’s exact test was used for comparison of categorical variables due to small expected cell counts; $p < 0.05$ was considered statistically significant.

Hospital Stay and Treatment Cost Analysis

Table VI shows that reduced-duration antibiotic therapy significantly decreased both hospital stay and treatment cost compared to standard therapy. Group A had

a shorter hospital stay (8.92 ± 1.14 vs 15.74 ± 5.38 days, $p<0.001$). Total treatment cost was significantly lower in the reduced-duration antibiotic group. The mean cost in Group A was $18,450\pm2,130$ BDT, compared to $32,780\pm6,420$ BDT in Group B

($p<0.001$), demonstrating a substantial economic advantage of shorter antibiotic therapy.

Table VI
Comparison of hospital stay and total treatment cost between study groups (n=126).

Outcome	Group A (Reduced-duration, n=63)	Group B (Standard-duration, n=63)	p-value
Hospital stays (days), mean ± SD	8.92 ± 1.14	15.74 ± 5.38	<0.001*
Total treatment cost (BDT), mean ± SD	18,450 ± 2,130	32,780 ± 6,420	<0.001*

Independent samples t-test; *Statistically significant (p < 0.05).

Follow-up Outcomes

Table VII shows, long-term neurological and developmental complications were uncommon in both groups. Seizure disorder was observed in one infant in each group

(1.6% vs 1.6%, p=1.000). Hearing impairment was detected only in Group B (3.2%), while developmental delay was also reported in a single case in Group B (1.6%). However, none of these differences reached

statistical significance between the groups (p>0.05), indicating comparable long-term outcomes following both reduced-duration and standard-duration antibiotic therapy.

Table VII
Follow-up outcomes (n=126).

Outcome	Group A n (%)	Group B n (%)	p-value
Seizure disorder	1 (1.6)	1 (1.6)	1.000
Hearing impairment	0 (0.0)	2 (3.2)	0.154
Developmental delay	0 (0.0)	1 (1.6)	0.314

Fisher's exact test was used for comparison of categorical variables due to small expected cell counts; p < 0.05 was considered statistically significant.

DISCUSSION

In this study, baseline characteristics were similar across groups, suggesting equivalent disease severity at enrollment. This aligns with the findings of Ali et al. (2018), which stated that bacterial meningitis in children from South Asia exhibits consistent, nonspecific clinical symptoms like fever and seizures, showing little variation at baseline [15]. The microbiological profile indicated a comparable distribution of pathogens across groups, with no significant differences apart from an increased presence of *Acinetobacter* spp. in Group B. This corresponds with Abedin MZ, who stated that in Bangladesh, pediatric bacterial meningitis is primarily due to Gram-negative bacteria like *Klebsiella*, *E. coli*, and *Pseudomonas*, with a growing prevalence of *Acinetobacter* in healthcare environments [16]. CSF analysis demonstrated notable improvement in both groups with no differences observed at day 7, reflecting comparable inflammatory resolution. This aligns with De Almeida et al. (2019), who indicated that CSF cell count, protein, and glucose progressively normalize with successful treatment of bacterial meningitis and indicate recovery, without differentiating among various suitable antibiotic therapies [17]. Initial clinical results were alike in both groups, showing similar recovery with reduced- and standard-duration treatment. This is consistent with the findings of Ouchenir et al. (2017), who noted that after the initiation of suitable antibiotics, fever and neurological improvement happen at comparable rates in infant bacterial meningitis, irrespective of treatment differences [18]. Negative outcomes were reduced in the shorter-duration group, with notably less sepsis, whereas mortality and

hydrocephalus showed no significant differences. This is consistent with de Jonge et al. (2010), who indicated that the outcomes of pediatric bacterial meningitis are primarily influenced by complications such as sepsis instead of the length of treatment, with sepsis being a crucial indicator of unfavorable prognosis [19]. Shortened therapy duration notably decreased hospital stays and treatment expenses, while maintaining outcomes. This matches findings from Balada-Llasat et al. (2019), which indicated that extended hospital stays significantly contribute to elevated costs in pediatric meningitis, and shortening the duration of stay greatly decreases total treatment costs [20]. The follow-up results were comparable between the two groups, showing no significant differences in seizures, hearing loss, or developmental delays. This is consistent with Briand et al. (2016), who indicated that long-term effects of pediatric bacterial meningitis primarily depend on the severity of the illness rather than differences in treatment, with outcomes generally similar following adequate therapy [21]. In general, findings are consistent with earlier research, demonstrating similar baseline, microbiological, CSF, and clinical results, with shorter treatment duration markedly decreasing complications, hospital length, and expenses while maintaining efficacy and long-term results.

CONCLUSION

Reduced-duration antibiotic therapy in uncomplicated bacterial meningitis among infants up to two months of age was found to be as clinically effective as standard-duration therapy in terms of early recovery, CSF improvement, and long-term neurological outcomes. Importantly, it was associated with a significant reduction in hospital stay and treatment cost, without increasing mortality or neurological

complications. Therefore, reduced-duration antibiotic therapy may be considered a safe, effective, and cost-efficient alternative in carefully selected cases of uncomplicated infantile bacterial meningitis, particularly in resource-limited settings.

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