

## CT scan in children with acute bacterial meningitis: Experience from Emergency Department of a tertiary-care hospital in Karachi, Pakistan

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### Abstract

**Objective:** To determine the role of computed tomography scan in children presenting to emergency department with symptoms and signs of suspected acute bacterial meningitis.

**Methods:** The retrospective analysis was done on children who were admitted through the Emergency Department at Aga Khan University Hospital, Karachi, from September 2009 to September 2011 with the diagnosis of acute bacterial meningitis. Information related to age, gender, presenting complaints, clinical signs and symptoms, computed tomography scan findings and final outcome of patients was gathered from the medical records. SPSS 19 was used for statistical analysis.

**Results:** A total of 192 patients were admitted with the relevant diagnosis. The male-female ratio was 2.3:1. Computed tomography scan was done in 114 (59.4%) patients. The scan was reported normal in 90 (78.94%) patients. However, cerebral oedema was found in 16 (14.03%) patients, cerebral infarct in 6 (5.26%) and hydrocephalus in 2 (1.75%) patients. Overall, there were 6 (3.1%) deaths.

**Conclusion:** Computed tomography scan may have a beneficial role in children with acute bacterial meningitis. However, further studies are required to use the scan as a routine investigation for such a diagnosis.

**Keywords:** Acute bacterial meningitis, Children, Emergency department, Computed tomography. (JPMA 64: 419; 2014)

### Introduction

Acute bacterial meningitis (ABM) is a leading cause of childhood febrile illnesses.<sup>1,2</sup> According to the World Health Organisation (WHO) estimates, each year ABM cases number at least 1.2 million globally, and of those 135,000 result in deaths.<sup>3</sup> ABM is among the top 10 causes of infection-related deaths in children worldwide.<sup>4</sup> Despite the advancement in diagnostic and treatment modalities, morbidity and mortality is high, especially in the paediatric age group.<sup>5-8</sup> Fatality rates from bacterial meningitis could be as low as 2% in infants and children, and as high as 20-30% in neonates and adults.<sup>2,9,10</sup> An Indian study reported an ABM fatality rate of 16% in children.<sup>11</sup> Even if the child survives, the acute illness, morbidity in the form of long-term morbidity such as seizure disorders, hearing loss and hydrocephalus, has been reported in one-third of survivors.<sup>4,12,13</sup>

When clinical diagnosis of ABM is suspected, the common practice, in a high-income setting especially, is to do a computed tomography (CT) brain scan to exclude raised intracranial pressure (ICP) and cerebral herniation, especially in older children in whom fontanels are closed.<sup>14</sup> Raised ICP is very common among children with

meningitis and clinically significant raised ICP cannot be ruled out by CT scan.<sup>15</sup> Studies have shown that CT is not necessary in patients without any overt clinical signs of complications.<sup>16</sup> It is unsafe to transport patients to radiology for CT scan which could result in treatment delay and ultimately bad outcome masking the usefulness of imaging.<sup>17</sup> It is now well known that CT scan has a higher radiation exposure, approximately 500 times, than a normal X-ray. Children are more radio-sensitive. A 1-year-old child is 10 to 15 times more likely to develop a malignancy than a 50-year-old adult secondary to the same radiologic dose. High cost and radiation exposure with less therapeutic benefit has limited its utilization, especially in countries with inadequate resources.<sup>18,19</sup>

Cerebral herniation has been reported in 5% of patients with ABM, resulting in mortality in 30% of the cases.<sup>20</sup> Although a CT scan of the head is useful to look at the contraindications to lumbar puncture (LP), but a normal CT scan does not mean that it is safe to perform LP. The signs of 'impending' herniation on clinical examination are the better indicators of delaying an LP as the risk of precipitating herniation is always there, even with a normal CT scan.<sup>20,21</sup> In the absence of clinical findings, patients are likely to have a normal CT scan with 97% negative predictive value.<sup>22</sup>

In Pakistan, no data has been reported on the CT scan usage in children with ABM. Therefore the aim of the current study was to determine the role of CT scan in

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children with ABM presenting to the Emergency Department (ED) of a Karachi-based hospital.

### Patients and Methods

The retrospective chart review study was conducted at the Aga Khan University Hospital (AKUH), Karachi, from September 2009 to September 2011, and comprised records of all patients with ABM admitted through the ED.

All children between the age of 1 month and 14 years presenting to the ED and having LP-proven ABM were included, while those with other central nervous system CNS diseases, like brain tumours, intracranial bleeds, structural malformations of brain, were excluded as were those who were immuno-compromised.

After the approval of institutional review board, charts of all patients were reviewed and information was noted in a pre-designed proforma. The patients were divided into 3 age groups: less than 1 year;  $\geq 1$  - 5 years; and more than 5 years. Data was collected on age, gender, presenting complaint such as seizure, drowsiness, signs like focal neurological signs, whether CT scan and Fundoscopy was done or not, and the findings of CT scan and Fundoscopy, and patient disposition from ED.

Data was entered and analyzed using SPSS version 19.0. Descriptive statistics were run to describe patient's demographics. Results of categorical variables were expressed in frequencies and percentages and mean and standard deviation were reported for continuous variables. Cross tabulation of CT scan findings was done with the duration of symptoms, level of admission, hospital length of stay and final disposition to find out any correlation with the severity of illness with imaging findings using Chi-square test as test of significance for categorical data and t-test for continuous data. Level of significance ( $\alpha$ ) was set at 5%.

### Results

Of the 14,537 paediatric ED visits, 192 (1.32%) were admitted with LP proven ABM diagnosis. Of them, 134 (69.8%) were males and 58 (30.2%) were females; the male-female ratio being 2.3:1. The average duration of symptoms was  $4.88 \pm 5.92$  days. Majority of the patients were admitted to the hospital; 152 (79.1%) to the wards and 40 (20.8%) to either the special care unit (SCU) or intensive care unit (ICU). The average length of stay in the hospital was  $5.26 \pm 4.04$  days. Fever was the most common symptom present in 163 (84.9%) patients, vomiting in 93 (48.4%), headache 77 (40.1%) and irritability in 54 (28.1%) patients respectively (Table-1). Fundoscopy was done in only 49 (25.5%) patients. It was normal in 44 (89.7%), while suggestive of meningitis in 5 (10.2%) patients.

CT scan was done in 114 (59.4%) patients. It was reported normal in 90 (78.94%), while cerebral oedema was reported in 16 (14.03%), cerebral infarct in 6 (5.26%) and hydrocephalus in 2 (1.75%). Among the 114 patients in whom CT scan was performed, 30 (26.3%) presented with seizures; of these 19 (63.3%) had normal CT scan, while 11 (36.7%) had abnormal finding ( $p < 0.015$ ) (Table-2). Twenty (17.5%) children presented with drowsiness; of these 9 (45%) had abnormal CT findings like cerebral oedema in 5 patients, cerebral infarct in 3 patients and hydrocephalus in

**Table-1:** Characteristics of patients admitted with acute bacterial meningitis (n=192).

Patient characteristics	n (%)
<b>Age (in years)</b>	
Less than 1 year	53 (27.6)
Between 1- <5years	48 (25.0)
More than equal to 5 years	91 (47.4)
<b>Gender</b>	
Male	134 (69.8)
Female	58 (30.2)
<b>GCS Score</b>	
Less than 8	7 (3.6)
Between 8-13	37 (19.3)
More than 13	148 (77.1)
<b>Findings on history and physical Examination ( n = 192)</b>	
Fever	163 (84.89)
Vomiting	93 (48.44)
Headache	77 (40.1)
Irritability	54 (28.12)
Neck stiffness	53 (27.6)
Drowsiness	26 (13.5)
Seizures	47 (24.48)
Photophobia less than a week	6 (3.12)
Bulging fontanels	14 (7.29)
Kerning's sign positive	26 (13.54)
Brudzinski's sign positive	18 (9.37)
Deteriorating or reduced level of consciousness present	4 (2.08)
<b>CT Finding (n=114)</b>	
Normal	90 (46.9)
Cerebral oedema	16 (8.3)
Hydrocephalus	2 (1.0)
Cerebral infarct	6 (3.1)
<b>Disposition from ED (n=192)</b>	
Ward	149 (79.1)
SCU	25 (13.0)
PICU	15 (7.8)
<b>Length of hospital stay</b>	
Less than a week	159 (82.8)
More than a week	33 (17.2)
<b>Final Disposition from hospital</b>	
Discharged	179 (93.2)
Expired	6 (3.1)
LAMA	7 (3.6)

GCS: Glasgow Coma Scale. CT: Computed Tomography. ED: Emergency Department. SCU: Special Care Unit. ICU: Intensive Care Unit. LAMA: Left Against Medical Advice.

**Table-2:** Comparison of patient characteristics with CT scan findings (n=114).

	Normal (n=90) n (%)	CT Scan finding Abnormal (n=24) n (%)	Total (n=114) n (%)	P-value
<b>Basic Demographics</b>				
<b>Age Group</b>				
< 1 year	13 (61.9)	8 (38.1)	21(18.4)	0.102
≥1- <5 years	26 (81.3)	6 (18.8)	32(28.0)	
≥ 5 years	51 (83.6)	10 (16.4)	61(53.5)	
<b>Duration of symptoms (n=108)</b>				
Less than a week	67 (79.8)	17 (20.2)	84(73.7)	0.593
More than a week	18 (75.0)	6 (25.0)	30(26.3)	
<b>Clinical History</b>				
<b>History of seizure</b>				
No	71 (84.5)	13 (15.5)	84(73.7)	0.015*
Yes	19 (63.3)	11 (36.7)	30(26.3)	
<b>Drowsiness</b>				
No	79 (84.0)	15 (16.0)	94(82.5)	<0.01*
Yes	11 (55.0)	9 (45.0)	20(17.5)	
<b>Focal Neurological sign present</b>				
No	90 (79.6)	23 (20.4)	113(99.1)	0.211
Yes	0 (0.0)	1 (100.0)	1(0.88)	
<b>GCS Score</b>				
Less than 8	4 (57.1)	3 (42.9)	7(6.14)	0.001*
Between 8-13	14 (56.0)	11 (44.0)	25(21.9)	
More than 13	72 (87.8)	10 (12.2)	82(71.9)	
<b>Headache</b>				
No	42 (71.2)	17 (28.8)	59(51.7)	0.035*
Yes	48 (87.3)	7 (12.7)	55(48.2)	
<b>Hospitalization</b>				
<b>Level of Admission (n=112)</b>				
Ward	71 (87.7)	10 (12.3)	81(71.0)	<0.01*
SCU	9 (50.0)	9 (50.0)	18(15.7)	
PICU	9 (69.2)	4 (30.8)	13(11.4)	
<b>Length of stay</b>				
Less than a week	75 (82.4)	16 (17.6)	91(79.8)	0.071
More than a week	15 (65.2)	8 (34.8)	23(20.1)	
<b>Final Disposition</b>				
Discharge	85 (80.2)	21 (19.8)	106(92.9)	0.355
LAMA	3 (75.0)	1 (25.0)	4(3.5)	
Expired	2 (50.0)	2 (50.0)	4(3.5)	

\*Statistically significant.

GCS: Glasgow Coma Scale. CT: Computed Tomography. ED: Emergency Department. SCU: Special Care Unit. ICU: Intensive Care Unit. LAMA: Leave Against Medical Advice.

1, while 11(55.0%) had normal CT scan ( $p < 0.01$ ). Headache was present in 55 (48.2%) patients and CT scan showed abnormal findings in 7(12.7%) ( $p = 0.035$ ). All the 32 (28%) patients with Glasgow Coma Scale (GCS) of  $< 13$  underwent CT scan which was abnormal in 14(12.3%). Of the 40 (20.8%) patients admitted to either the SCU or ICU, 13(11.4%) had abnormalities on CT scan. Duration of symptoms were less than a week in 84(73.7%) and more than a week in 30 (26.3%) patients. Among the patients in whom CT scan had been done, 4 (3.5%) expired, with 2 (50%) having cerebral

infarct on CT scan. Discharged patients were 106 (92.9%), with 21(19.8%) showing abnormal findings on CT scan.

## Discussion

ABM is one of the common diseases due to which children visit EDs and hospitals. The trend to do CT scan before LP is on the rise, especially in facilities where it is easily available. It has now become the standard of care worldwide, especially in USA and Europe.<sup>23</sup> Due to lack of clear guidelines, it is quite difficult for ED physicians to decide

whether the patient requires CT scan of brain before doing LP. When there is a fear of litigation of medical malpractice especially, this leads to a common practice where physicians get CT scan done on every patient before doing LP.

Our study showed increasing numbers of CT scan being ordered in ABM and their limited role in finding raised ICP. It also showed unpredictability of clinical parameters which leads to suspecting ABM. CT scan of the brain has limited role in ABM and it is mistakenly used to identify and rule out raised ICP.<sup>24</sup> Our study showed that around 60% of ABM patients had CT scan done before LP and more than three-fourth of these had normal scan findings. Earlier studies have reported similar results.<sup>26,27</sup> One study found almost similar result where 88% and 86% of patients with meningitis had normal CT scan.<sup>27</sup>

It is better to decide about performing LP on clinical grounds and establishing local guidelines would be of significant help for the physicians. Clinical parameters are quite unpredictable in suspecting clinical diagnosis of ABM. Commonly presenting symptoms are quite non-specific for meningitis. A study from India also had similar findings where infants presented with fever, irritability, drowsing and vomiting, while older ones presented with headache, vomiting, neck rigidity and back pain.<sup>5,28</sup>

Being a retrospective, single-centre study, the current study has its limitations. More prospective studies are required to further address the usefulness of CT scan in children presenting with ABM.

## Conclusion

CT scan is not routinely done in all ABM patients in low-income settings. Children having signs and symptoms of drowsiness, headache or low GCS may have abnormal finding on CT scan.

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