

## Analysis of the indications for routine lumbar puncture and results of cerebrospinal fluid examination in children admitted to the paediatric wards of two hospitals in East Africa

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**Abstract:** Lumbar puncture (LP) is an important diagnostic tool for investigating neurological conditions/diseases. This study was carried out to compare the indications for lumbar puncture and findings of cerebrospinal fluid examination in children admitted to Muhimbili National Hospital (MNH) in Dar-es-salaam, Tanzania and Kilifi District Hospital (KDH) in Kenya. Records of all children admitted to the paediatric wards of the two hospitals from 1st November 2004 to 30th April 2005 with suspected central nervous system infections and had LPs performed were analysed. Overall, 8,741 paediatric admissions were recorded in the two hospitals (Muhimbili = 6,228; Kilifi = 2,513). Of these, 607 (6.9%) had a LP performed; 154 out of 6,228 (2.5%) in MNH and 453 out of 2,513 (18.0%) in KDH. LPs were performed less frequently in Muhimbili than in Kilifi Hospital. The most common indications for LP at MNH were convulsions (62.5%), neck stiffness (14.3%) and prostration (17%), whereas at KDH were convulsions (56.3%), neck stiffness (7.3%) and prostration (22.1%). The bacterial isolates were rarely (23%) obtained on culture at both hospitals. *Streptococcus pneumoniae* and *Salmonella* species were the commonest causes of pyogenic meningitis. In conclusion, the rate of LP performance in the two hospitals is low. There is need therefore to improve the rates of LP and the isolation of bacterial pathogens from cerebrospinal fluid cultures. Other possible causes for meningitis such as viruses need to be investigated.

**Key words:** lumbar puncture, cerebro-spinal fluid, children, infections, Tanzania, Kenya

### Introduction

A lumbar puncture (LP) is a procedure performed to collect a sample of cerebrospinal fluid (CSF) for biochemical, microbiological and cytological analysis. This technique is important in the diagnosis of a variety of infectious and non-infectious neurological conditions. The most common indication for a lumbar puncture is to collect cerebrospinal fluid in a case of suspected bacterial meningitis. Lumbar punctures are also performed to administer intrathecal medications for spinal anaesthesia.

At Muhimbili National Hospital (MNH) in Tanzania, indications for LP have been adapted from the Integrated Management of Childhood Illnesses (IMCI) guidelines. In neonates these include fever ( $\geq 38.5^\circ\text{C}$ ) or hypothermia, bulging fontanelle (or acute increase in head circumference), high-pitched cry, irritability, lethargy, altered mental state and poor feeding. Bacterial meningitis is usually suspected in a patient ( $>3$  months including adolescents) with a history of fever and headache, photophobia, stiff neck, irritability or lethargy, vomiting and altered state of consciousness or convulsions. In such patients, LP is indicated. Patients are usually initiated on treatment with antibiotics and antimalarials targeting suspected bacterial meningitis and severe malaria often before

the LP is performed. This is because delays may be associated with processing and obtaining LP results. At the MNH, pathogens are isolated from very few CSF specimens. This has limited the utility of CSF results in guiding treatment among clinicians who hardly get positive results (G. Herbert, unpubl.)

At Kilifi District Hospital (KDH) in eastern Kenya, LPs are indicated in patients with altered level of consciousness, history of convulsions in a child  $<2$  years or prostration in children  $<3$  years. It is also performed as part of septic screening in neonates. This hospital currently serves as a centre of excellence in monitoring invasive haemophilus and pneumococcal (bacteraemia and meningitis) in Kenya. Acute bacterial meningitis (ABM) is an important indication for LP in most of hospitalised cases. ABM is associated with high mortality in children (Wiersinga *et al.*, 2004). Data on the indication for LPs and/ or CSF examination is scarce in East Africa. Such data are important to provide information of the level of performance in management of CNS pathology and other neurological diseases especially in this era of HIV/AIDS. The objective of this study was therefore to compare indications for LPs and CSF examination results among children admitted to MNH and KDH in Tanzania and Kenya, respectively.

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## Materials and Methods

The Muhimbili National Hospital in Dar es Salaam, Tanzania and Kilifi District Hospital in Kenya were involved in the study. A retrospective review of patients who had LPs over a six-month period from November 2004 to April 2005 was conducted. This included all children admitted to the paediatrics wards and suspected to have central nervous system infections and had LPs performed.

Data was extracted from patient's clinical notes and laboratory registers held in both hard copies and electronic databases. At MNH, patients who had a LP performed were identified from the laboratory registry and their clinical notes traced. A data sheet was constructed to collect the required information from patients files, microbiology and biochemistry laboratories. An electronic database was available at KDH. An electronic request form was filled asking specifically for data on patients who had LPs during the specified period. Variables collected included: demographic characteristics such as age and sex of the patient, symptoms and signs of CNS infections such as convulsions, unconsciousness, bulging fontanelle and neck stiffness. Results of CSF

laboratory examination of sugar, protein, white blood cell count and culture were recorded.

Data were entered using Epi-Info 2002 software and Excel and analysed using version 8 of the STATA software package (Stata Corp, College Station, Texas).

## Results

A total of 8,741 admissions (MNH= 6,228; KDH= 2,513) to the paediatric wards were recorded. Of these, 607 (6.9%) had a LP performed; 154 out of 6,228 (2.5%) at MNH and 453 out of 2,513 (18.0%) at KDH. However 42 patients at MNH were excluded from the analysis due to missing data. Therefore, a total of 565 patients in the two hospitals were included in the data analysis; 112 from MNH and 453 from KDH. Most of the patients at MNH were females (60.7%) whereas males (52.8%) dominated in the number of patients admitted to KDH. Of the total admission 50% were children < 1 year. The most common symptoms and indications for lumbar puncture are summarised in Table 1. None of the study participants had LPs performed for the purpose of intra-thecal medication or anaesthesia.

**Table 1: Symptoms and signs in patients who had LP performed at Kilifi and Muhimbili Hospitals**

Symptom and signs	Muhimbili (N=112)		Kilifi (N =453)	
	n	%	N	%
Fever	104	92.9	387	85.4
Convulsions	70	62.5	255	56.3
Irritability	11	10	50	11.0
Prostration	19	17.0	100	22.1
Unconsciousness	16	14.3	45	10.0
Neck stiffness	16	14.3	33	7.3
Lethargy	11	10	33	7.3
Bulging fontanelle	16	8.0	16	3.5

**Key:** n= number of patients with a particular symptom or sign  
N= total number of patients involved in the study in each hospital

**Table 2: The levels of CSF sugar and protein in patients at Kilifi and Muhimbili Hospitals**

CSF parameters	Kilifi (%), N=453	Muhimbili (%), N=112
CSF WBC /mm <sup>3</sup>		
<10	88.3	83.3
10 – 50*	6.7	6.7
>50**	5.0	7.1
CSF/Blood sugar ratio		
<0.1	***	15.0
0.1-0.67	***	45.7
>0.67	***	39.3
CSF protein g/L		
£0.4	12.9	60.4
>0.4	87.1	39.6

**Key:** \* Possible meningitis; \*\*Probable meningitis; \*\*\*blood sugar levels not determined

**Table 3: Common organisms isolated from CSF samples at Kilifi and Muhimbili Hospitals**

Organism	Kilifi		Muhimbili	
	<2months	>2months	<2months	>2months
Acinetobacter	1	0	0	0
Bacillus spp	1	0	0	1
Beta haemolytic streptococcus	1	0	0	0
Salmonella spp	0	2	0	0
<i>Streptococcus pneumoniae</i>	2	4	0	0
<i>Streptococcus pyogenes</i>	1	0	0	0
<i>Escherichia coli</i>	0	0	0	1
<i>Haemophilus influenza</i>	0	0	0	1
No growth	110	330	7	102
Total	116	336	7	105

Important differences existed between the two hospitals with regard to indications for performing a LP. KDH had its own established criteria as indications for performing a LP, a protocol that is followed by attending clinicians. MNH used the IMCI guidelines for signs and symptoms of CNS pathology to decide on the need of performing a LP. Convulsions and prostration were the most common indication for doing LP in both hospitals.

There were few CSF samples collected for biochemical and cytological studies at MNH than at KDH (Table 2). Analysis of CSF, protein and blood sugar levels were performed in all 453 patients at KDH. The mean CSF sugar was 3.1 (SD 1.6) mmol/L and the median was 3.0 mmol/L. At MNH, only CSF sugar level was performed in 86 of the 112 (77%) patients, thus CSF sugar ratio was not calculated. The mean CSF sugar was 2.95 (SD= 1.1) mmol/L and the median was 3.0mmol/L. At KDH, the majority showed normal protein levels with a mean CSF protein of 0.66 (SD 0.40) g/L and a median of 0.3 g/L. The majority of patients from MNH had abnormal CSF protein compared to KDH (87.1 versus 39.6%). The MNH mean CSF protein was 1.79 (SD= 1.1)g/L and the median was 1.5g/L. Bacterial isolates were rarely obtained on culture in both hospitals. Over 97% of the samples had no isolates (Table 3). There were differences in the isolates found in the two hospitals, with one *Bacillus* contaminant in both populations. *Streptococcus pneumoniae* and *Salmonella* species were the most common causes isolates in patients >2months at KDH. No pathogens were isolated in children <2 months at MNH.

## Discussion

Our study has shown that only a few LPs are performed among children admitted to Muhimbili National Hospital in Tanzania as compared to Kilifi District

Hospital in Kenya. The rate of LPs at Kilifi was seven-fold that of MNH. The availability of clear guidelines outlining the indications for LP and a mechanism for strict adherence to the protocol at KDH ensures that children who need a LP get it. Moreover, the automated data management system, as well as the well-established laboratory back up for microbiological studies at Kilifi means improved accuracy in data collection. However, at Muhimbili the method of data collection and incompleteness of records are likely to have contributed to the omission of some cases during data analysis. It is however important to note that most patients at MNH had abnormal CSF proteins suggesting that at least patients with overt features of meningitis get a LP.

Suspected pyogenic meningitis was the main indication for a LP at the two hospitals. Similar findings have been reported in southern Tanzania (Wiersinga *et al.*, 2004). Although some differences were observed in the organisms isolated from CSF samples at the two hospitals, it is difficult to make any conclusions given the small number of observations. However, a striking observation is the absence of *H. influenzae* at KDH and only one case at MNH, a finding that may reflect the effectiveness of the recently introduced Hib vaccines in the childhood immunisation schedule.

In over 97% of samples submitted for microbiological analysis, no organisms were isolated. It is possible that the absence of organisms on cerebrospinal fluid culture is due to pre-treatment with antibiotics (McCarron *et al.*, 1996). On the other hand, it is possible that many of these cases are due to viral meningitis suggesting that such infections may be a common cause of meningitis in the hospitals. Prospective studies should be designed to establish this.

In a recent study at MNH *Streptococcus pneumoniae*, *S. neoformans* and *H. influenzae* type B were the commonest isolates in children aged < 15 years with clinical meningitis (Matee & Matre, 2001). Similarly, *S. pneumoniae* and *H. influenzae* (41.9%)

were the predominant isolates among children admitted with acute bacterial meningitis between 1994 and 2000 (Mwangi *et al.*, 2002). It has been documented that outside the neonatal period, *Neisseria meningitidis*, *S. pneumoniae* and *H. influenzae* are responsible for over 90% of cases of bacterial meningitis (Hart, 1996).

Performing LP in children is one of the useful investigations procedure for detecting CNS infections or pathology. In some hospitals, LPs are rarely performed, mainly because of the low rate of isolation of bacterial pathogens even in patients with overt features of acute bacterial meningitis. This may be due to prior antibiotic therapy or poor handling of CSF specimens including delays in processing specimens. In addition, lack of proper guidelines and delays associated with waiting for LP results have contributed against its utility in guiding treatment.

In other hospitals the procedure is carried out to help differentiating bacterial meningitis from other diagnoses among children who present with febrile seizures, neck stiffness, unconsciousness, symptoms and signs of complex seizures (Laditan, 1995; Berkley *et al.*, 2001). Sometimes presumptive treatment with antibiotics and antimalarials targeting suspected bacterial meningitis and cerebral malaria is initiated before performing LP. Such a practice avoids delays in initiating life-saving treatment and thus complications of cerebral malaria or bacterial meningitis. In a study conducted on indicators of acute bacterial meningitis in children at a rural Kenyan district, 2.0% of all admissions had the disease which was the most common indication for a LP. In this study, independent predictors for ABM were a bulging fontanelle, neck stiffness, cyanosis, impaired consciousness, partial seizures, and seizures outside the febrile convulsions age range (Kanegaye *et al.*, 2001).

The sterilization of CSF with antibiotic pre-treatment may influence the yield from CSF and may complicate decisions on whether to continue with treatment or not. Failure to perform LPs may result in unwarranted prolonged treatment with antibiotics if the clinical presentation and other laboratory findings cannot exclude ABM.

In conclusion, LPs are performed less frequently at Muhimbili than Kilifi Hospital. Pneumococcus and Salmonella species are the commonest causes of pyogenic meningitis. It is recommended that strategies should be put in place to improve the rates of lumbar puncture in the two hospitals and the isolation of bacterial pathogens from cerebrospinal fluid cultures. Development of clear guidelines/protocols for lumbar

punctures may be useful. Such protocols should be audited regularly.

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