Causative Organisms and Risk Factors In Bacterial Meningitis in Al-Elwia Childhood Hospital - Baghdad

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Abstract

Background: Childhood meningitis is a major cause of morbidity and mortality, Hemophilus influenza b (Hib) is the most common cause in many countries, especially below 5 years and before the development of conjugated Hib vaccine, it is followed by Streptococcus Pneumonia, and then N. meningitides, in addition to other microorganisms.

Objective: To identify the causative organisms of bacterial meningitis and to identify the factors predisposing significantly to the incidence of bacterial meningitis.

Method: This cross sectional , study was done in Al-Elwia Pediatric Hospital during the period 1st of January 2007 to 30th of June 2007.Eighty four patients with presumptive diagnosis of meningitis were included in this study, from the age of 2 months -12 years, History about some risk factors were taken in details. Analysis of cerebrospinal Fluid (CSF) with Gram stains & cultures were done in all cases.

Results: The number of cases of meningitis was 50 (20 proved meningitis & 30 partially treated meningitis), while 34 patients are found to have no meningitis.

Streptococcus pneumoniae was identified in 45%, Hemophilus Influenza b in 20%, while Nisseria meningitides 5%, other organisms include Escherichia coli, Staphylococcus aureus, Klebsiella, & salmonella.

Many factors affecting the occurrence of bacterial meningitis & these include: age, sex, residence, body weight and home overcrowding.

Conclusions: Streptococcus pneumoniae was found to be the predominant microorganism causing bacterial meningitis in children aged 2 months-12 years, followed by Hemophilus influenza b, while N. meningitides were one of the rare bacteria which had been identified. E. coli was found to be the major cause in cases of ventriculo-peritoneal (VP) shunt meningitis.

Keywords: Meningitis. Bacteria. Risk factors

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Introduction

Meningitis is an inflammation of the meninges & the subarachnoid cerebrospinal fluid that surrounds the brain and spinal cord [(1)]. Childhood meningitis is a major cause of morbidity & mortality in many parts of the world [(2)]; it is a serious condition owing to the proximity of the location to the brain and spinal cord [(1).]

It can be caused by virtually any organism; in general viral infections are more common than bacterial, which in turn, are more common than fungal and parasitic infections [(1, 2, and 3)].

Pyogenic (bacterial) meningitis is a life threatening disease; it is associated with high rate of acute complications and morbidity [(3, 4, and 5)]. Causes of bacterial meningitis in infant and children (age ranging from 2 months-12 years) include**:** Haemophilus influenzae type b (Hib), Streptococcus pneumoniae (S.pneumoniae), Neisseria meningitides (N.meningitides) and other microorganisms: Staphylococcus aureus, E.coli, Salmonella typhimerium, and Klebsiella [(6, 7, and 8)]. In general bacterial meningitis occur in male gender more than female [(9)], in one study in Al-Anbar governorate on two age groups, they found that in first 2 years of age group male: female incidence of meningitis was 1.4:1, while after that age group male: female ratio was 2.1:1[(5)].

Bacterial meningitis occurs with increased frequency in certain population groups. Native Americans are at particular risk for Hib meningitis, black race about 2-3 folds higher than white in contracting S. pneumonia meningitis and this may result from the underlying factors such as poverty and sickle cell anemia[(10,11)].

S.pneumonae meningitis usually occurs in the winter and spring, while N. meningitides meningitis occur through the year [12, 13, 14]. Viral Upper Respiratory Infection (URTI) also predispose to N. meningitides meningitis in both tropical and temperate conditions. [15, 16, 17, 18] Lumbosacral dermal sinus & meningomylocele are associated with staphylococcal and gram negative enteric bacterial meningitis, shunt infections increase the risk of meningitis due to staphylococci (especially coagulase-negative species) and other cutaneous bacteria[3,19,20].

Household contact with an infected sibling may increase the risk of Hib disease up to 500 folds and the house crowding increase the risk of Hib due to increased exposure to household infected person [13]

Exposure to tobacco smoking is a risk factor to develop pneumococcal meningitis, by the same mechanism as viral Upper respiratory tract infection (URTI) which had been mentioned [21, 22, and 23].

The effect of low birth weight on the incidence of meningococcal meningitis is very similar among mature and preterm children and it is associated with increased risk of incidence throughout childhood [22, 24]. Premature children have an increase risk of occurrence of meningococcal meningitis during the first year of life only [22].

Low socioeconomic status is often associated with crowding of living condition which increases the risk of contact with Hib infected person and Neisseria meningitides meningitis [13, 23, and 25].

The diagnosis of meningitis is confirmed by analysis of CSF, so it should be done whenever it is suspected.[5] The CSF leukocyte count in bacterial meningitis is usually elevated greater than 1000 /mm,^{3} typically there is neutrophilic predominance, but it is less than 250 / mm^3 in as many as 20 % of patient with acute bacterial meningitis. CSF glucose in bacterial meningitis usually is decreased (less then 40% or 50% of the serum sugar^3, it is below 40 mg/dl in about 60% of the patients) & the CSF /serum glucose is below 0.31 in 70 % of cases[6].

The CSF protein is raised (100-500 mg/dl) in virtually all patients with bacterial meningitis. Confirmation of diagnosis requires the isolation of the specific bacterial pathogen by microscopy. [10, 6]. Latex agglutination test is an easy test to perform; nevertheless, it should not substitute the conventional methods for diagnosis (Gram stain &culture).

The Aim of study is to identify the causative organisms of bacterial meningitis and to identify the factors predisposing significantly to the occurrence of bacterial meningitis.

Method

This is a cross sectional -hospital based study, done in the emergency ward of Al-Elwia pediatrics hospital during the period (1st of January 2007-30th of June 2007).

All patients with suspected meningitis as judged by senior were enrolled in the study. They were drained by lumbar puncture, & in some cases by fontanel tapping, e.g., in cases of meningomylocele & these tappings were done by neurosurgeons after consultation.

All these procedures were performed under aseptic technique & the samples were immediately sent to the laboratory of the hospital, where they were processed & examined by laboratory technicians. Portion of CSF samples were taken to examination by Gram stain, an other portion of CSF was cultured for bacteria by direct inoculation in 5% blood agar plate, chocolate agar plate, & were incubated at 37 C^o for 24-72 hr, followed by subculture in agar plate, sensitivity in positive culture was determined by the comparative disc diffusion media. Another part of CSF sample was used for cytology & differential count, while the rest was examined for estimation of glucose & protein content in the CSF.

We classified our patients in the study into two groups, according to the method of classification used by El-Amin *et al* [26] these groups include:-

1-bactrial meningitis (considered as a cases group): This group includes:

I) proved bacterial meningitis: it was defined as the presence of an organism in the CSF demonstrated by culture and or Gram stain; these are accompanied by changes in the CSF cytology, sugar, & protein contents.

II) Partially treated meningitis: those patients received antibiotics treatment prior to admission & no organism could be seen in CSF culture & Gram stain, but there is CSF pleocytosis & the differential count exceed 60% polymorphs, the CSF/ blood glucose ratio was under 60%, & the protein concentration exceeding 45 mg/dl.

2-negative results (no meningitis), considered as control group

These patients were clinically suspected meningitis but no evidence of abnormal laboratory findings in CSF (no pleocytosis, CSF glucose/ blood glucose more than 60% & protein concentration is less than 45 mg/dl), no growth of bacteria in CSF culture, and no bacteria was identified on Gram stain.

We excluded patients who are suspected to have viral meningitis: patients with pleocytosis with lymphocyte constitute more than 60%, with CSF/ blood sugar more than 60 % & protein less than 45 mg/ dl & no organism were identified on Gram stain & culture.

Information which was collected from both groups include: age, sex, residence, primary health care attendance within two weeks before illness, passive smoking at home, birth weight & maturity, crowding at home, & associated chronic diseases including URTI within the last two weeks before admission.

Statistical analysis was done using SPSS software package version 10. Chi-Square test & odd ratio were applied to estimate a significant association. [27]. P. value less than 0.05 considered statistically significant.

Results

The total number of patients with presumptive diagnosis of meningitis was 84, out of them, 50 (60%) were considered as cases of meningitis.

Twenty cases (40%) of them are proved meningitis by Gram stain &/or culture, & 30 cases (60%) are partially treated meningitis, while 34 (40%) have no meningitis & were considered as controls.

We have two age groups; the first age group is 2 months-24 months, while the second is 2 years-12years.The number of suspected cases in the first age group (2-24 months) was 55 (65%) & in the second age group (2-12 year) is 29 (35%).The number of proven cases of meningitis in the first age group was 38 (76%) while in the second group is 12 (24%).

The male: female ratio (the number) was 1.2:1 (45:39) for suspected meningitis & 1.3:1 (28:22) for cases of meningitis, while it is 1:1(17:17) for control group.

The urban: rural ratio (the number) is 2:1 (56: 28) for suspected meningitis, it is 4:1 (40: 10) for meningitis cases & while it is 0.8:1(16:18) for control group.

The following table (1) explains the numbers, percentage of cases & controls regarding the age, gender, & residence.

Table 1. Characters of the samples.

	Cases No (%)	Control No (%)	Total No (%)
Age			
2-24 months	38 (76)	17 (50)	55 (65)
2-12 years	12 (24)	17 (50)	29 (35)
Gender			
male	28 (56)	17 (50)	45 (54)
female	22 (44)	17 (50)	39 (46)
Residence			
Urban	40 (80)	16 (47)	56 (67)
Rural	10 (20)	18 (53)	28 (33)
Total	50 (100)	34 (100)	

Clinical manifestations of the cases and control patients are explained in the following table (2):

Table 2 .Clinical manifestations of all patients

Symptoms & signs	**cases**		**control**	
	present	absent	present	absent
	No (%)	No (%)	No (%)	No (%)
Fever	45 (90)	5 (10)	28 (82)	6 (18)
Decreased appetite	36 (72)	14 (28)	30 (88)	4 (12)
Disturbed conscious.	36 (72)	14 (28)	20 (59)	14 (41)
Convulsion	23 (46)	27(54)	15(44)	19 (56)
Vomiting	17 (34)	33 (66)	5 (15)	29 (85)
Bulging fontanel	12 (24)	38 (76)	4 (12)	30 (88)
Neck stiffness	12 (24)	38 (76)	3 (9)	31 (91)
Headache	7 (14)	43 (86)	1 (3)	33 (97)
Kerning sign	6 (12)	44 (88)	0 (0)	34 (100)
Brudzinski sign	3 (6)	47 (94)	0 (0)	34(100)
Focal neurological sign	2 (4)	48 (98)	0 (0)	34 (100)

The following table (3) explains the results of Direct Gram stain & culture of CSF among the cases group, while for control group neither positive.

Table 3. Direct Gram stain & Culture of CSF in cases of meningitis.

	Gram stain		Culture	
The organism	**NO. of cases**	**%**	**NO. of cases**	**%**
Streptococcus pneumoniae	5	10	9	18
Haemophilus influenza	3	6	4	8
E. Coli	1	2	3	6
Neisseria meningitides	0	0	1	2
Staph. aureus	0	0	1	2
Klebsiella	0	0	1	2
Salmonella	0	0	1	2
Total Positive	9	8	20	40
Negative	41	82	30	60
Total	50	100	50	100

Many contributing factors for meningitis are studied as shown following table (4).

Table 4. Risk factors for bacterial meningitis.

	Cases		Control		P value	Odd ratio	95% Confidence interval	
Factor	**NO**	**%**	**NO**	**%**			**lower**	**upper**
Body weight					0.016	3.379	1.188	9.612
Below 5 th percentile	21	42	6	18				
Above or equal to 5th percentile	29	58	28	82				
Birth weight					0.204	0.551	0.188	1.617
Above 2.5 kg	36	72	28	82				
Equal or below 2.5 kg	14	82	6	18				
Maturity at birth					0.209	0.384	0.075	1.973
Full term	43	86	32	94				
Preterm	7	14	2	6				
Home-crowding					0.059	2.265	0.914	5.615
Crowded	26	52	11	32				
Non-crowded	24	48	23	68				
Smoking at home					0.04	0.395	0.157	0.995
Smoking	37	74	18	53				
No smoking	13	26	16	47				
Associated diseases					0.007			
Neural tube defect	7	14	1	3				
Pneumonia	11	22	2	6				
Gastro-enteritis	7	14	3	9				
URTI within 2 weeks					0.007	0.291	0.117	0.725
Present	34	68	13	38				
Absent	16	32	21	62				
Primary health care attendance one month before					0.041	0.413	0.169	1.009
Yes	30	60	13	38				
No	20	40	21	62				

Discussion

It is very important for pediatricians to increase knowledge about meningitis because it is a major cause of morbidity & mortality all over world.

The causative organisms are identified on Gram stain and culture of CSF in only 40% and this is mostly due to the overuse of antibiotics in our society by many medical personnels & this partly because the early sign & symptoms of meningitis are often non specific & confusing, so the high index of suspicion must be required by all doctors & especially physicians.

In the present study; S. pneumoniae was found to be the predominant causative microorganism (45%), followed by Hib (20%), while N. meningitides is identified in only one case (5%), these results are similar to that found in study was done in Al-Anbar governorate, in which S. pneumoniae is predominant (54.3%) then Hib (34.5%) and rarely for N. meningitides (2.5%), while these findings are different from that found by many investigators else where, who found that the predominant agent was Hib followed by S. pneumoniae & this difference might be due to many epidemiological factors regarding the prevalence of microorganism, in particular, the nasopharyngeal colonization which represent an important risk factor[5,28].

Other organisms causing meningitis include E. coli (15%), Klebsiella (5%) & S. aureus (5%), these occur due to ventriculo-peritoneal shunt meningitis which is an important risk factor predisposing for meningitis, while its known that coagulase negative Staphylococcus are isolated in more than half, Staphylococcus aureus in approximately 20% and G-ve bacilli in 15% [3] this difference may be due to small number of cases of shunt meningitis taken in our study & more wide study is advised.

Salmonella typhimerium was identified on CSF & blood culture in only one patient (5%) of 2 months old with gastroenteritis & this is similar to the study done in Al-Anbar which identify one case of S typhimerium, while in a study done in Children Hospital Ministry of Public Health, Bangkok, Thailand, they found that Salmonella species in 12.4% of cases of meningitis & it occurs exclusively in infant, about 87% of them were under 6 months of age.[29]

This study showed that body weight is a significant risk factor affecting the occurrence of bacterial meningitis (P=0.016; OR 3.379, 95% CI 1.188-9.612), these result are similar to that study done in North America on the risk factor for pneumococcal meningitis where they found its 3.5 times pneumococcal meningitis occurs in children with failure to thrive than those children with well body built [30]

Birth weight & maturity are not significantly affecting the occurrence of bacterial meningitis in children, for birth weight (P=0.204; OR=0.5. 95% CI 0.188-1.617), & for maturity at birth (P=0.209; OR 0.384, 95% CI 0.075-1.973), while in a study done in Denmark on the relationship between prematurity, low birth weight, & meningococcal meningitis, there is a persistent effect of low birth weight on the incidence of meningococcal meningitis in all age groups.

Increased risk of meningococcal meningitis during the first 12 months of life is associated with prematurity (adjusted OR=1.3, 95% CI 1.1-1.9) [22], our results are different because the present study is not restricted to meningococcal meningitis & N. meningitides is one of the rare organisms identified in the present study,

Home crowding is significantly affecting the frequency of bacterial meningitis (OR= 2.265, 95% CI 0.353-4.53), the same result is present for pneumoccocal meningitis in North America, while in Auckland, meningococcal meningitis in children is 10 times increased in crowded conditions[25]. Low socioeconomic state often associated with crowding living condition which increases the risk of contact with Hib infected person & Neisseria meningitides meningitis [13, 23, and 25].

Smoking at home is significantly associated but not a predisposing factor for bacterial meningitis (P=0.04; OR=0.395, 95% CI 0.157-0.995), the same result are reached in Auckland for meningococcal meningitis [25].

Viral URTI within 2 weeks is a significantly associated with bacterial meningitis with P value (0.007) & OR (0.291, 95% CI 0.117-0.725), this result is similar to that result for pneumoccocal meningitis in North America (P=0.04; OR 0.3, 95% CI 0.075-1.934) [31], & in meningococcal meningitis viral URTI affect its incidence in Auckland (P =0.003; OR 1.5, 95% CI 1.0-2.5) [25].

The normal removal of S. pneumonia bacteria from respiratory passages by cilia may be interrupted by edema, ciliary damage or increased mucus caused by viral infection or smoking, it is common for viral URTI to precede pneumoccocal meningitis which occur more commonly during winter & spring [17]. Children exposed to tobacco smoking are 2.5 times more likely to develop bacterial meningitis & diagnosed patient with purulent meningitis were three times more likely to have been exposed to second hold smoke in the home. Exposure to tobacco smoking is a risk factor to develop pneumococcal meningitis, by the same mechanism as viral URTI which had been mentioned [21].

Maternal smoking in pregnancy associated with increased risk of meningococcal diseases[22], active or passive smoking are independently associated with meningococcal carriage & this significantly increase with heavier smoking[10].

Bacterial meningitis occurs in high in association with other specific diseases (P=0.007) and these include neural tube defects and VP shunt, pneumonia, and gastroenteritis, in study in USA, university of Scranton, they found bacterial meningitis occur significantly in neural tube defect[31].

Primary health care attendance is significant in cases for bacterial meningitis (P=0.041) but it is not risk factor (OR 0.413, 95% CI 0.69-1.009).

Conclusions

1. S. pneumoniae was found to be the predominant microorganism causing bacteria meningitis in children from 2 months-12 years old, followed by Hib, while N. meningitides was one of the rare bacteria which had been identified. E. coli was found to be the major cause in cases of VP shunt meningitis.
2. Many factors were associated with greater risk of meningitis & these include: age, sex, residence, body weight, & home crowding, others are significantly associated but not a risk factors for bacterial meningitis & these include: household smoking, URTI, primary health care attendance, & associated diseases, e.g., neural tube defect & VP shunt, pneumonia, & gastroenteritis, while others were neither significantly associated nor a risk factors, e.g., birth weight & prematurity.

Recommendations

1. High suspicion index of meningitis must be required by all pediatricians to diagnose meningitis and starting antibiotic therapy.
2. We recommend introducing a heptavalent conjugate vaccine against S. pneumoniae & conjugate vaccine against Hib to the routine vaccinations, while meningococcal vaccine for high risk children.
3. We recommend introducing certain programs to the general population about the effect of crowding & poor house conditions including ventilation.

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