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Specificity and Sensitivity of signs and symptoms in bacterial meningitis

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Abstract
Prospective study extending along 5 months period from January 2004 TO July 2004, 63 patients were collected, from these admitted to causality dept of pediatrics teaching hospital with suspicion of meningitis, they were clinically evaluated with signs and symptoms of meningitis, and CSF analysis. The final diagnostic tool for meningitis (the patients were divided into 4 age groups, the sensitivity, specificity, positive predictive value and the accuracy for the symptoms and signs of meningitis were calculated for each group. From the study we conclude that for each age group there are some signs, symptoms, sensitive for the diagnosis of Meningitis in children according to the age groups. Performing a lumbar puncture in doubtful cases of meningitis is better than missing a case of meningitis with its sequelae.

Keywords: meningitis, children, lumber puncture

Introduction

Practitioners who see children most frequently diagnose and treat pediatric infectious diseases. They must decide which children have relatively benign illnesses and which have septicemia or meningitis. The presentation of serious infections may not be obvious. Practitioners must be able to rappdly recognize and manage meningitis. This diagnosis should be considered in any child with thermal instability and / or CNS dysfunction. Like the surgeon who must perform some negative laparotomies to avoid missing cases of appendicitis, the percentage of negative lumber punctures in order to avoid missing cases of meningitis. The first step in providing appropriate therapy is to recognize signs and symptoms that suggest a high probability of meningitis the practitioner needs to pay careful attention to all aspects of clinical assessment as the signs symptoms can be very subtle.As is true with many other pediatric illnesses, the younger the child, the more nonspecific are the signs and symptoms [1]. Neonates with meningitis lack specific manifestations diagnosing these patients can be a formidable problem nay state that the infant feeds poorly or has a fever, but even these sings may be absent restlessness and irritability that is inconsolable may be the only clues, Use of subtle observations can greatly aid in the detection of sick children especially infants social contact or "playfulness " is a major indicator of health Appropriate contact with both the examiner and the surrounding environment may be the single best predicator for general well-being Neonates with meningitis lack specific manifestations; Restlessness and irritability that is inconsolable may be the only clues. Neurologic sings may or may not be present. Neurologic manifestations include lethargy (50-90%); bulging or full fontanel (20-30%); focal, generalized, or subtle seizures (30-50%); nuchal rigidity (10-20%) and, rarely at initial presentation, signs of increased intracranial pressure [2]. Most patients beyond the neonatal period with bacterial meningitis appear acutely ill. Other etiologies of the child 'toxic presentation must also be considered, including septicemia without coexistent meningitis, Septicemia must be ruled out because of its high potential for morbidity and mortality, and because of the possibility of coexisting meningitis. Other major infections, especially pneumonia, may present with a board range of nonspecific findings in a toxic infant [3]. In older infants and children, meningitis may be easily diagnosed by presenting signs and symptoms. Fever, irritability, of sensorium generalized seizure activity, focal neurologic sings, photophobia, anorexia, and vomiting are frequently seen in children with meningitis. Verbal children typically complain of a serve headache. Children with meningeal irritation often prefer not to walk but rather remain recumbent, sometimes assuming the fetal position. After the first year of life, nuchal rigidity is reliably seen in the acute phase of meningitis. It is not seen immediately after seizure activity when both of the Kerning and Brzezinski signs are also absent. The absence of rigidity at any age, however, does not rule out intracranial infection. Nuchal rigidity, a more specific sign of meningeal irritation, occurs in less than a quarter of infants with meningitis. Similarlt, a bulging fontanel, diastasis of the sutures, or opisthotonos may be seen infrequently late in the course of meningitis [4]. Nuchal rigidity should always provoke strong consideration of meningitis. However, many other conditions may present with an apparent "stiff neck" including both very serious (pneumonia peritonsillar abscess, brain tumor) and less serious (cervical adenitis and toricollis) conditions. Trauma may complicate the differential diagnosis Although in most instances the practitioner will know by the history that child had a traumatic insult, in the case of child abuse, that clue will often be lacking, children with head trauma and intracranial hemorrhage, especially those with the "shaken baby syndrome" often present as if they had a febrile meningitis Retinal bleeding on ophthalmoscopy and bloody CSF on lumber puncture, however, should suggest trauma. Infants and young children are particularly vulnerable because of immature immune response and lack of previous exposure to the organisms commonly causing meningitis [5]. Haemophilus influenza, Neisseria meningitides and streptococcus pneumonia account for about three-quarter of those cases of bacterial meningitis in which the responsible

agent is isolated. In most cases, the agent reaches the meninges via the blood stream, probably through the choroid plexus, having originated from the upper respiratory tract. An intense inflammatory meningeal reaction ensured, with exudation and neutrophil leukocytosis. In those patients who have the illness, postmortem examination reveals clouding of the meninges with opalescent streaks surrounding the cortical veins overlaying the hemisphere convexities. Microscopy reveals polymorphonuclear and mononuclear cells with hemorrhages lying between the pia and fibrinous exudate appears and extends into the sulci and the Virchow-Robin spaces. Vasculitis follows in the superficial cortical vessels and over base of the brain. The cranial nerves are often engulfed in the exudates [6]. Clinical features include fever, headache, signs of meningeal irritation and clouding of consciousness. Those patients admitted in coma have a poor prognosis, as do the very young and the already. The finding of focal neurological signs, or the appearance of focal signs, probably reflects a complicating vasculitis. Signs of meningeal irritation are sometimes lacking in the elderly and in deeply comatose patients. A petechial rash is particularly associated with meningococcal meningitis, where it occurs in about 50 per cent of cases, but is seen with meningitis due to other organisms(e.g. Escherichia coli) [7] Meningitis in children typically presents as either a subacute infection that gets progressively worse over several days and was preceded by an upper resirratory tract infection (URL) or otitis media, or as an acute fylminant illness that develops rapidly in a few clinical presentation of bacterial meningitis may be alerted slightly by prior antibiotic therpy in the pediatric age group. Children who have been treated with oral antibiotics for a URL or otitis media prior the development of signs and symptoms of meningitis may have a longer duration of symptoms, more physical findings of ear, nose or throat infections, and less of a temperature elevation than children who have not had prior oral antibiotic therapy. Seizures occur in 4% of children with bacterial meningitis typically during the first few days of the illness. The majority of seizures have a focal onset. Seizures activity that has a focal onset which is caused by: 1-Focal arterial ischemia or infection.2-Cortical venous thrombosis with hemorrhage. 3-Focal edema. 4-Mass effect from an expanding subdural effusion. Or generalized seizure activity and status epilepticus which is caused by: Fever. Hyponatremia. Anixia from decreased cerebral perfusion. Spread from a focal onset to a generalized tonic-clonic convulsion [8]. Lumber puncture for evaluation of the CSF remains the mainstay of diagnosis though the procedure is potentially hazardous if there is acute brain swelling, a finding particularly associated with infection due to H. influenza. The CSF pressure is usually elevated. The protein concentration is raised in most patients, though seldom above 5g/1. The cell count, predominantly polymorph nuclear may reach 100,000 cells/mm3. In rare cases, the count is barely raised, or even normal. Glucose concentration below 2.2mmol/1 are found in about half the cases. Comparison of CSF with plasma glucose levels has take account of the delay between any changes in plasma glucose concentration being mirrored in the CSF. Gram staining is positive in up to three quarters of cases. Fialure to identify the organism by either Gram staining of culture is encountered in up to a quarter of cases. Papilledema is uncommon in uncomplicated meningitis and should suggest a more chronic process, such as the presence of an intracranial abscess, subdural empyema, or occlusion of a ssdural venous sinus [9]. All CSF tests have sensitivity and specificity for detecting infection. Although the optimal CSF test would confirm CNS infection in all persons with an infection and exclude infection in all persons without the disease (100% specificity), most tests are either highly sensitive or highly specific, but not both. The diagnostic sensitivity of a test is defend as the proportion of persons with an CNS infection who have positive test result, and specificity is the proportion of persons without an CNS infection who have negative rest results. If the diagnostic sensitivity is low, a high proportion of tests will not detect an infection when one is present (many false negatives), while if the specificity is low, there will be a high proportion of tests that report an infection when one is not present (many false positives). An most CNS infections are serious and many are treatable, it is often more important that a CFS tests be highly sensitive so that the diagnosis of CNS infection is not missed [10, 11, 12, 13].

Aim of the study

The aim of this study is to evaluate several commonly used clinical signs and symptoms in diagnosing meningitis by calculating the sensitivity, specificity, positive value and accuracy for each symptoms and sign of meningitis

Patients and Method

The study included the children admitted to the department of causality of child teaching hospital with suspicion of meningitis 63 patients were collected and evaluated prospectively along 5 months period from January 2004-May 2004. After initial clinical assessment, a form was filled in detailing the history and examination of patients were divided 4 groups.1-6 months, 7-12 months, 1-5 year**,** 6-10 year. The symptoms stressed upon in the history as prediction of meningitis were vomiting, headache, fever, reluctance, to feed, convulsion and URTL. The signs, which were looked for as predictors of meningitis, were irritability, lethargy, neck rigidity, Kernig's sign, Brudzinki sign, papilledema, bulging fontanel the classical signs of meningitis were defined as follow: Neck rigidity was regarded as present when the neck resists passive flexion. Kering sign is elicited with the patient in the supine position.

The thigh is flexed on the abdomen with knee flexed, attempts to passively extend. The leg elicited pair when meningeal irritation is present. Brudziniski's sign is positive when passive. Flexion of the neck (with the patients in the supine position) results is in spontaneous flexion of the hips and knees [7]. The fundi of some the patients excluding neonates, were examined and their state was fixed as having papll edeme or not, lumbar puncture was done for all the patients to decide whether the patient is having bacterial meningitis or not. The classical SCF abnormalotoes in the meningitis were regarded as follow: Increased opening pressure. Aupleocystosis of polymorphonuclear leukocytes (100-1000) cells/mm3 or more. Decreased glucose concentration (40 mg/dl) an increased protein concentration (100-5—mg/dl) [14]. The sensitivity, specificity, positive predictive value and accuracy were culcalted for each symptom and sign in disgnosing meningitis. Its value as

positive symptom or sign in disgnosing meningitis was assessed as follow:-

Sensitivity
Sensitivity measures the ability of a symptom or sign to detect cases of meningitis. It's defined by the number of true positives divided by the total patients with meningitis.

Specificity
Specificity measures the ability of a sign to detect cases of meningitis. It's defined the number of true negatives divided by the total patients without meningitis.

Positive predictive value
The positive value of a symptom or sign gives a measure of the significance of a positive result. It's defined by the proportion of true cases of meningitis among all those with a positive symptom or sign.

Accuracy
The accuracy of a symptom or sign gives an overall value of a test to correctly detect those patients with meningitis and exclude those without meningitis. It's defined by the number of true positives and negatives divided by the number of patients tested [15].

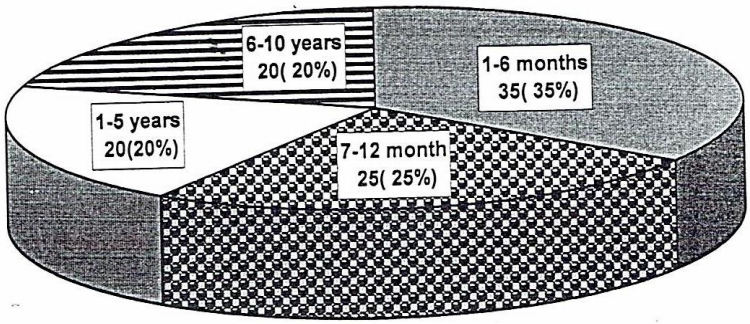

Fig 1: Distribution according age group

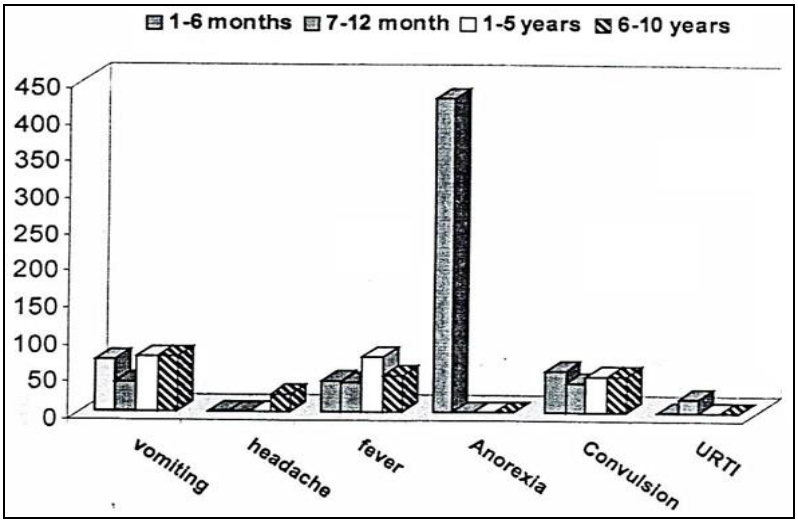

Fig 2: symptoms of meningitis

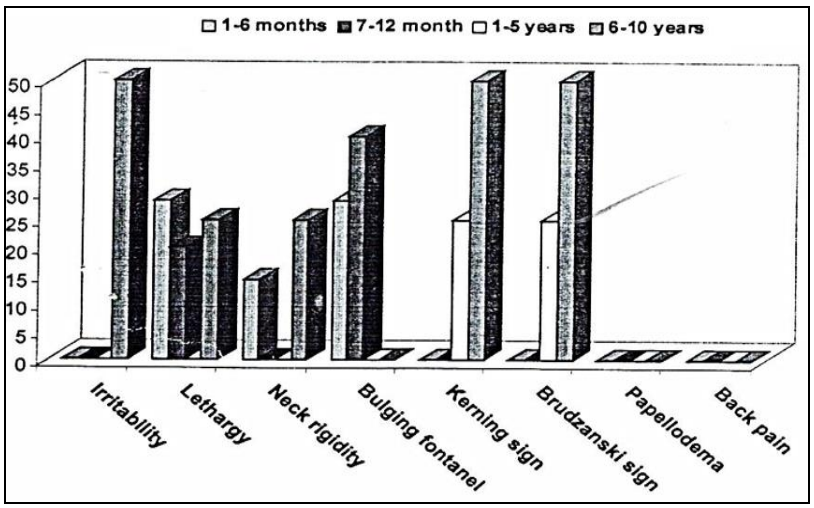

Fig 3: signs of meningitis

Table 1: Distribution of symptoms in differentiation of age group

Symptoms	1-6 months N=7		7-12 months N=5		1-5 years n=4		6-10 years n=4	
	No.	%	No.	%	No.	%	No.	%
Voming	5	71.4	2	40	3	75	3	75
Headache	0	0	0	0	0	0	1	25
Fever	3	42.8	2	40	3	75	2	50
Anorexia	3	42.8	0	0	0	0	0	0
Convusion	4	57.1	2	40	2	50	2	50
URTI	0	0	1	0	0	0	0	0

Table 2: Distribution of signs in differentiation of age group

Symptoms	1-6 months N=7		7-12 months N=5		1-5 years n=4		6-10 years n=4	
	No.	%	No.	%	No.	%	No.	%
Irritaility	0	0	0	0	0	0	2	50
Lathargy	2	28.5	1	2	0	0	1	25
Neck rigidity	0	0	0	0	0	0	1	25
Bulging fontanel	2	28.5	2	40	0	0	0	0
Kering sign	0	0	0	0	1	25	2	50
Brudzanki sign	0	0	0	0	1	25	2	50
Papellodema	0	0	0	0	0	0	0	0
Back pain	0	0	0	0	0	0	0	0

Age group (1-6 months)

Table 3: Sensitivity, specificity, positive predictive value and accuracy of symptoms and signs in prediction meningitis in the patients aged (1-6months) suspected to have meningitis

Symptoms	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Vomting	80	100	80	100	71.4
Headache	0	100	0	28.5	28,5
Fever	60	100	100	66.66	71.4
Relacting to feed	20	100	50	20	28.4
Convulsion	80	100	100	66.66	85.71
URTI	0	100	0	28.5	8.5

Signs	Sensitivity	specificity	PV+ve	PV-ve	Accuracy
Irritability	0	100	0	28.5	28.5
Lethargy	40	100	100	40	56.8
Neck rigidity	0	100	0	28.5	28.5
Bulging fontanel	40	100	100	40	56.8
Kerning sign	0	100	0	40	28.5
50 Brudzanki sign	0	100	0	40	28.5
Papellodema	0	100	0	40	28.5
Back apin	0	100	0	40	28.5

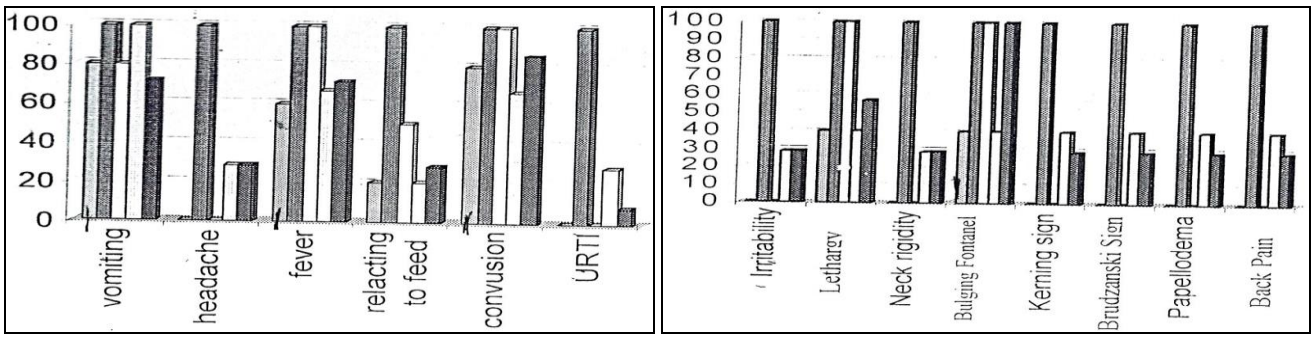

Fig 4: (above: Symptoms, below: signs): Sensitivity, Specificity of Symptoms and Sign in predicting meningitis in the patients aged (1-6 months Suspected to have meningitis

Age group (1-5 Years)

Table 3: Sensitivity, specificity, positive predictive value and accuracy of symptoms and signs in prediction meningitis in the patients aged (1-5 year) suspected to have meningitis

Symptoms	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Vomting	100	100	100	100	
Headache	0	100	0	25	

Fever	100	100	100	100	
Relacting to feed	0	100	0	25	
Convulsion	66.66	100	100	50	
URTI	0	100	0	25	

Signs	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Irritability	0	100	0	25	25
Lethargy	0	100	0	25	25
Neck rigidity	0	100	0	25	25
Bulging fontanel	66.66	100	100	50	75
Kerning sign	33.33	100	100	33.33	50
50 Brudzanki sign	33.33	100	100	33.33	50
Papellodema	0	100	0	25	25
Back	0	100	0	25	25

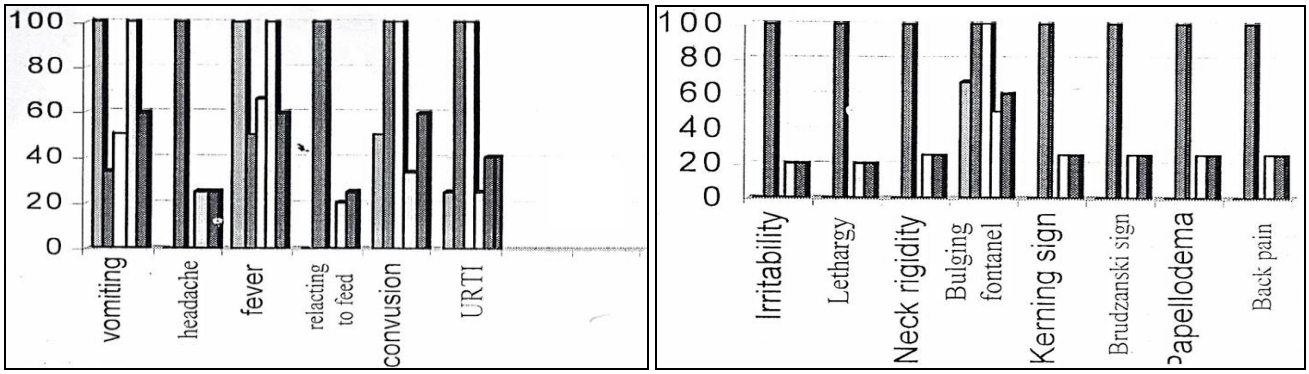

Fig 5: (above: symptoms, below: Signs): Sensitivity, Specificity of Symptom and sign in Predicting me meningitis in the patients aged (1-5 years Suspected to have meningitis

Age group (7-12 months)

Table 4: Sensitivity, specificity, positive predictive value and accuracy of symptoms and signs in prediction meningitis in the patients aged (7-12 months) suspected to have meningitis

Symptoms	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Vomting	100	33.3	50	100	60
Headache	0	100	0	25	25
Fever	100	50	66.66	100	60
Relacting to feed	0	100	0	20	25
Convulsion	50	100	100	33.33	60
URTI	25	100	100	25	40

Signs	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Irritability	0	100	0	20	20
Lethargy	0	100	0	20	20
Neck rigidity	0	100	0	25	25
Bulging fontanel	66.66	100	100	50	60
Kerning sign	0	100	0	25	25
50 Brudzanki sign	0	100	0	25	25
Papellodema	0	100	0	25	25
Back apin	0	100	0	25	25

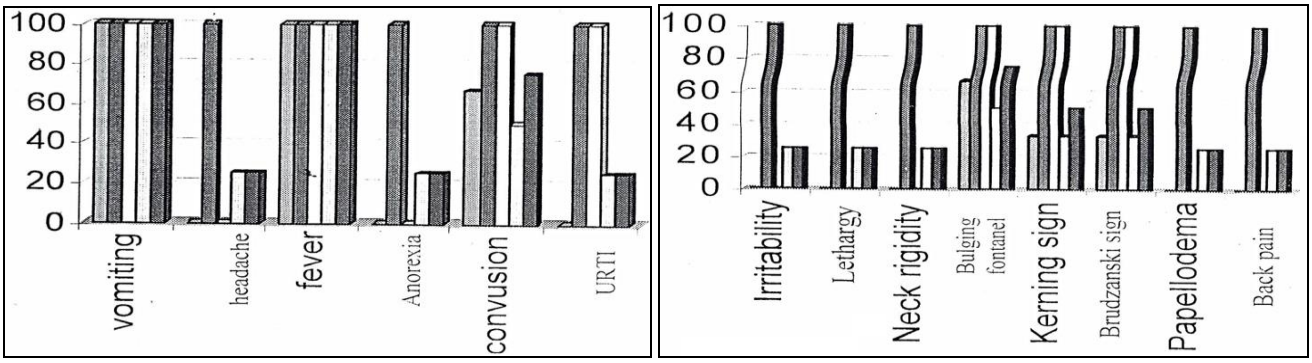

Fig 6: (above: Symptoms, below: Signs): Sensitivity, Specificity of Symptoms and Sign in Predicting meningitis it is in the patients aged (7-12 months) Suspected to have meningitis

Age group (6-10years)

Table 6: Sensitivity, Specificity. Positive predictive value and accuracy of symptoms and signs in predicting meningitis in the patients aged (6-10 year) suspected to have meningitis.

Symptoms	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Vomting	100	100	100	100	100
Headache	100	50	66.66	100	75
Fever	100	50	66.66	100	75
Relacting to feed	0	100	0	25	25
Convulsion	66.66	100	100	50	75
URTI	0	100	0	25	25

Signs	sensitivity	specificity	PV+ve	PV-ve	Accuracy
Irritability	66.66	100	100	50	75
Lethargy	0	100	0	25	25
Neck rigidity	66.66	100	100	50	75
Bulging fontanel	0	100	0	25	25
Kerning sign	33.33	100	100	33.33	50
50 Brudzanki sign	33.33	100	100	33.33	50
Papellodema	0	100	0	25	25
Back apin	0	100	0	25	25

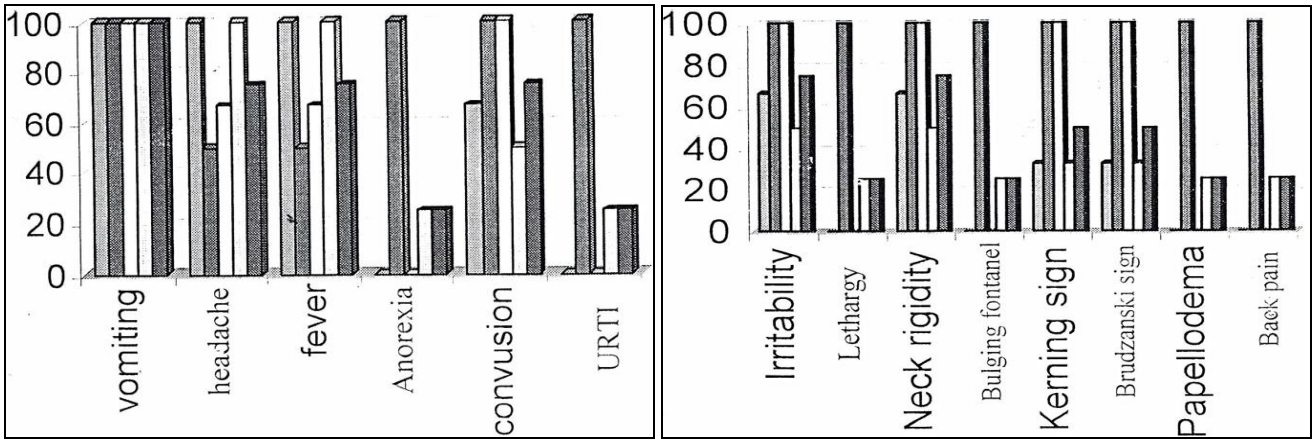

Fig 7: (above: Symptoms, below: Signs): Sensitivity, Specificity of Symptoms and signs in Predicting me meningitis in the Patients aged (6-10 years) Suspected to have meningitis

Discussion

Bacterial meningitis is one of the most potentially serious infections in infants and older children. This infection is associated with a high rate of acute complications and risk of chronic morbidity. The pattern of bacterial meningitis and it's treatment during the neonatal period (0-28 days) are generally distinct from those in older infants and children, nonetheless, the clinical patterns of meningitis in the neonatal and post neonatal periods may overlap, especially in the 1-2 months. Old patients in whom group B-streptococcus, H. influenzae type b, meningococcus and pneumococcus may all produce meningitis. [16] The aim of any symptom or sign used in the assessment of patients suspected to have meningitis is to be sensitive. (Not miss any case of meningitis), and specific (few negative lumber puncture). [10, 13] Fleisher mentioned that (neonates with meningitis lack specific manifestations and diagnosing these patients can be a problem) [1]. The initial signs and symptoms in neonates with meningitis may be indistinguishable from those of other infections and non-infection diseases of the newborn infants [2]. The signs and symptoms of neonates of meningitis are related to the non-specific finding associated with a systemic infection or bacteremia. Yet, convulsion and lethargy in our study showed some importance in diagnosing meningitis in neonates. For the patients of age group 1-6 months, we have found that fever and convulsion bulgy fontanel and lethargy were the most sensitive signs. In fact signs and symptoms of meningitis may overlap in the age groups 1 month and 1-6 months. In the age group 7-12 months vomiting and fever and convulsion the most sensitive symptoms of meningitis while bulging fontanel [17]. Less Rennick get al mentioned that seizures occur in 40% of children with bacterial meningitis typically during the first few days of the illness [8]. Kliegman. *et al*. mentioned that neck digidity should always strong consideration of meningitis although, many other conditions may present with any apparent. Stiff neck like pnenmonia, peritonsillar abscess, brain tumor and others [3]. For the age groups 1-5 years and 6-10 years, vomiting and fever, convulsing and headache it's the most sensitive symptoms. These symptoms although in our study were of significances but still are shared in the other diseases, which makes them as vague presentations. For the signs again neck rigidity and irritability were the most sensitive, Kernig's signs, Brudzinski sign and papilledema are of less importance. McCarthy mentioned that after the first year of life, neck rigidity is reliable seen in the acute phase of meningitis, it is not seen immediately, after seizure activity when both the Kerings and Brudzinski signs are also blunted. The absence of neck rigidity at any age, however,

does not rule out intracranial infection [4]. Karen L Rods concluding from her study on bacterial meningitis in childhood. (Stiff neck is the pathognomoic sign of meningeal irritations [18].

Conclusions

1-The principal diagnostic tool in this study was thet there were some sensitive and specific sign and symptoms reliable to detect meningitis especially in the young age (1-6) months. Yet, convulsion – lethargy, irritability and Bulging fontanel should raise the suspicion of the diagnosis of meningitis, while there. Is no place for the signs of meningeal irritation, in this group in the diagnosis of meningitis. 2-For age group (7-12 months), convulsion, lethargy fever, bulging fontanel are more dependable in the diagnosis of meningitis while the sign of meningeal are not dependable. 3-In the older age group (1-5 year) and (6-10) years, vomiting, headache, neck rigidity irritability, lethargy should raise the possibility of meningitis. 4-The absence of neck rigidity at any age does not rule out intracranial infection.

Recommendation

Performing a lumbar puncture with CSF analysis, in any case with doubtful diagnosis of meningitis, with a negative result is far better than missing a case of meningitis with subsequent brain damage or death.

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