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Bacterial Meningitis among children in Iraq

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1.0 Abstract

This research paper was done by the author as an independent study to investigate meningitis in children. the study focuses on the frequency of bacterial meningitis children. The epidemiology has been done according to the laboratory results of suspected cases in Central Child Teaching Hospital in Baghdad. From 1st of October 2017 until 28th of February 2018. The important finding that most common cause is the bacterial source among children. Among 117 patients 73 (62%) were male and 44 (37%) were female. The incidence of bacterial meningitis is highest among children younger than 1 year of age. Dramatic decrease in incidence after immunization with *Haemophilus Influenzae* type B (Hib) and valent pneumococcal vaccines. Incidence rates are highest during late winter and spring.

Keywords: meningitis, bacterial meningitis, children, immunization.

2.0 Introduction

History: meningitis was first described in the 1020s in Avicenna's The Canon of Medicine[(1)]and again more accurately by Avenzoar of al-Andalusia in the 12th century.[(2)]symptoms of the disease were also noted in 1805 by the Swiss GabinettoVieusseux (a scientific-literary association)during an outbreak in Geneva-Switzerland in 1887 Dr. Anton Weichselbaum(1845-1920)of Vienna became the first to isolate the specific germ meningococci.[(3)]

Meningitis is an infection of the subarachnoid space and leptomeninges caused by a variety of pathogenic organisms and continues to be an important source of morbidity and mortality. [(4)]

Meningitis may develop in response to number of causes most prominently bacterial as *Streptococcus pneumoniae*, *Neisseria meningitides*, *Haemophilus Influenzae*, *Escherichia coli*, Group B Streptococcus or viruses, physical injury, cancer and drugs. [(5)]

Acute bacterial meningitis remains an important cause of death and neurological sequelae in children, the clinical features of meningitis are often non-specific and may overlap with those of other infections. Early diagnosis and appropriate treatment are perhaps the most important steps in management, but published data suggested that fewer than half of the cases of meningitis are identified at first assessment. [(6,7)]

2.1 Aim of study: this study is aiming to:

1-To study the way in which meningitis presented to hospitals.

2-To study the acute complications of the disease and find the risk factors of those complicated cases.

2.2 Epidemiology

-The incidence of bacterial meningitis is highest among children younger than 1 year of age [8].- Dramatic decrease in incidence after immunization with Haemophilus Influenzae type B (Hib) and 7-valent pneumococcal vaccines [9].

-Incidence rates are highest during late winter and spring [10].

-The risk factors of meningitis include:

1-lack of immunity to specific pathogens associated with young age.
2-recent colonization with pathogenic bacteria.
3-close contact (household, daycarecenter , college dormitories)with individuals having invasive disease caused by HiB and N.meningitidis.
4-crowding, urban area.
5-poverty.
6-black race.
7-Male gender.
8-immunocompromised conditions (HIV, asplenia, complement deficiency, immunoglobulin deficiency, lymphocyte deficiency, malnutrition and malignancies).
9-penetrating head injuries, neurosurgical process.
10-CSF leak.
11-presence of VP shunt.
12-presence of cochlear implants.
13-Meningomylocele[11,12].

2.3 Etiology

Organisms causing meningitis are different in neonatal period from that causing meningitis beyond neonatal period [13].

Table 2.1 (Organisms causing neonatal meningitis[13])

Frequency of occurrence	Organisms
Common	Group B Streptococcus, *E.coli*
Uncommon	Other gram negative enteric bacilli, *Listeria Monocytogenes*, *Streptococcus Pnuomoniae*, Enterococci (faecal streptococci), other streptococci.
Rare	Coagulase negative Staphylococci, *Staph.aureus*, *H.inf.*(usually untypeable), *N.meningitidis* , anaerobes

Table 2.2 (Common bacterial pathogens beyond neonatal period[14])

Age or condition	Common bacterial pathogen
4-12 weeks	Group B streptococci, *S.pneumoniae*, *N.meningitidis*, *E.coli*, *H.influenzae*, *Listeria monocytogenes*
3months-18years	*S.pneumoniae* *H.influenzae* *N.meningitidis*
Immunocompromised host	*S.pneumoniae* *N.meningitidis* *Listeria monocytogenes* Gram negative bacilli including pseudomonas
Basilar skull fractures	*S.pneumoniae* *H.influenzae*, group A Streptococci
Head trauma Post neurosurgery	*S.aureus* *S.epidermidis* Gram negative bacilli including pseudomonas
CSF shunt infection	*S.epidermidis* *S.aureus* *P.acnes* Gram negative bacilli including pseudomonas

2.4 Pathology, Pathophysiology and Pathogenisis

A meningeal purulent exudates of varying thickness may be distributed around cerebral veins ,venous sinuses ,convexity of the brain ,cerebellum ,in the sulci , sylvian fissures ,basal cisterns and spinal cord .Ventriculitis with bacteria and inflammatory cells in ventricular fluid may be present (more often in neonates)as may subdural effusions and rarely empyema .perivascular inflammatory infiltrates also may be present and the ependymal membranes may be disrupted .vascular and parenchymal cerebral changes characterized by polymorphnuclear infiltrates extending to the subintimal region of the small arteries and veins , vasculitis ,thrombosis of the small cortical veins ,occlusion of major venous sinuses ,necrotizing arteritis producing subarachnoid hemorrhage and rarely cerebral cortical necrosis in the absence of identifiable thrombosis have been described at autopsy [(11)].

2.4.1Cerebral infarction: resulting from vascular occlusion due to inflammation,vasospasm and thrombosis is a frequent sequelae[(11)].

2.4.2 Increased ICP: is due to cell death (cytotoxic cerebral edema) cytokine induced increased capillary vascular permeability (vasogenic cerebral edema) and possibly increase hydrostatic pressure (interstitial cerebral edema) after obstructed reabsorption of CSF in the arachnoid villus or obstruction of the flow of fluids from the ventricle [(11)].Increase ICP induces pathologic changes via 2 mechanisms:

1-elevation of ICP reduces cerebral perfusion pressure and can lead to cerebral ischemia.
2-elevation of ICP may cause cerebral herniation[(15)].

SIADH: may produce excessive water retention and potentially increase the risk of elevated ICP Hypotonicity of brain extracellular spaces may cause cytotoxic edema after cell swelling and lysis.Tentorial, falxor cerebellar herniation doesn't occur usually because of increase ICP is transmitted to the entire subarachnoid space and there's structural displacement[(11)].

2.4.3 Hydrocephalus: can occur as an acute complication of bacterial meningitis. It most often takes the form of communicating hydrocephalus due to adhesive thickening of the arachnoid villi around the cisterns at the base of the brain. Thus there's interference with normal resorption of CSF. Less often obstructive hydrocephalus develops after fibrosis and gliosis of aquaduct of sylvius or the foramena of Magendie and Luschka[(11)].

2.4.4 Raised CSF proteins: are due to increase vascular permeability of blood brain barrier and the loss of albumin rich fluid from the capillaries and veins traversing the subdural space.continued transudation may result in subdural effusions usually found in the later phase of acute bacterial meningitis[(11)].

2.4.5 Hypoglycorrhachia: reduce CSF glucose levels is due to decrease glucose transport by the cerebral tissue[(11)].

These above pathologic factors result in clinical manifestations of impaired consciousness, seizures, cranial nerve deficit and later psychomotor retardation[(11)].

Meningitis result when pathogenic organism gain access to the subarachnoid space.The most common route is by hematogenous spread with invasion of the choroid plexus. less commonly bacteria gain access by direct introduction through trauma, congenital abnormalities such as a dermal sinus or spread from a contiguous site of infection like paranasal sinusitis, mastoiditis or cranial bone osteomylitis. Any bacteremic disease with a suitable pathogen can lead to meningitis .In the neonate organisms ingested during passage through the birth canal may colonize the nasopharynx and lead to bacteremia .In older infants and children bacteria such as *S.pnumoniae, N.meningitidis* and H. *influenzae* replicate in the nasopharynx cross the respiratory mucosa to the submucosal space and gain access to the blood stream and enter the CNS. once bacteria enter the subarachnoid space they multiply freely because there's little host defence in CNS [(16)].

2.5 Clinical manifestation

The signs and symptoms of meningitis are divided into:

1-non-specific findings: which include anorexia, poor feeding, headache, myalgia, symptoms of upper respiratory tract infection, arthralgia, tachycardia, hypotension, petechiae, erythematous macular rash.

2-meningeal irritation: include nuchal rigidity, back pain, kernig's sign, brudzinski's sign.

3-increase ICP: include headache, vomiting, bulging fontanelle, widening of the sutures, oculomotor or abducent nerve palsy, hypertension with bradycardia,apnea or hyperventilation,decorticate or decerbrate posturing, stupor, comapapilloedemais uncommon in uncomplicated meningitis and should suggest chronic process such as presence of intracranial abcess, subdural empyema.

4-focal neurological signs: focal seizures or generalized due to cerebritis,infarction or electrolyte disturbance.seizures can occur at presentation or within first 4 days of onset usually due to cerebral edema.

Seizures that persist after 4th day are difficult to treat and usually due to venous thrombosis and have poor prognosis [17,18,19].

2.6 Diagnosis

CSF analysis and culture remains the definitive method for diagnosis of meningitis. Analysis of CSF should include gram stain and culture, WBC count and differential,glucose and protein concentration,full blood count, urea and electrolytes should also have performed to look for any possible complication[20].

The criteria for definitive diagnosis of bacterial meningitis:

1-isolation of bacterial pathogen in one or more CSF cultures.
2-classic clinical manifestations include fever, disturbed consciousness, and signs of meningeal irritation.
3-typical CSF findings including leukocytes count>1000/mm^3 with predominant PMN cells and/or CSF protein concentration>1.5g/L and/or ratio of CSF glucose/blood sugar is<0.5[21].

Table 2.3 (CSF findings table in various types of meningitis [8])

condition	Pressure	Leukocytes	Protein	Glucose
normal	50-180	<4,lymphocytes 60-70%,30-40%monoctes,3%neutrophils	20-45mg/dl	>50%of serum glucose
Acute bacterial meningitis	Usually elevated	100-60000 PMN predominant	100-500mg/dl	<40% of blood glucose
Partially treated meningitis	Normal or elevated	1-10000 PMN usual	>100mg/dl	Decrease or normal
TB meningitis	Usually increase	10-500 PMN early but lymphocytes predominate later	100-500mg/dl	<50% usually
Fungal meningitis	Elevated	25-500PMN early,mononuclear cells later	20-500mg/dl	<50%
Viral meningitis	Normal or slightly elevated	PMN early,mononuclear cells later	<200mg/dl	Normal

Contraindications of LP:

1-signs of raised ICP with changing level of consciousness, focal neurological signs or severe mental impairment.
2-cardiovascular compromise with impaired peripheral perfusion or hypotension.
3-respiratory compromise with tachypnea,abnormal breathing pattern or hypoxia.
4-thrombocytopnia or a coagulopathy.
5-infection of skin overlying site of LP[22].

Indications of repeating LP:

1-meningitis caused by G-ve bacillus.
2-meningitis caused by resistant S.pneumoniae strain.
3-no improvement after 24-36 hours after treatment.
4-prolonged fever.
5-all neonates.
6-immunocompromised host[23].

2.6.1 Recommendation of neuroimaging in children during the course of meningitis:

1-newborns except for disease caused by L.monocytogenes.
2-seizures developed 72 hours after treatment.
3-continued excessive irritability.
4-focal neurological finding
5-persistant abnormal CSF indices.
6-recurrence or relapse
7-when the diagnosis is uncertain
8-increasing head circumference
9-when complications are suspected like subdural effusion, subdural empyema, brain abcess[20,23].

2.6.2 Indications of neuroimaging before LP:

1-signs of herniation(rapid alteration of consciousness, abnormality of pupil size and reaction, absence of oculocephalic response).
2-papilledema.
3-abnormalities in posture and respiration.
4-overwhelming shock or sepsis.
5-tonic seizures.
6-concern about condition mimicking bacterial meningitis (like intracranial mass, TB meningitis, Reye's syndrome) [24].

2.6.3Differential diagnosis: The signs and symptoms described earlier suggests meningeal or intracranial pathological process but are not pathogenomic of acute bacterial infection. Tuberculous meningitis, fungal meningitis, aseptic meningitis, brain abcess, intracranial or spinal epidural abcess, cranialosteomylitis, subdural empyema,bacterial endocarditis with embolism, ruptured dermoid cyst, ruptured spinal ependymomas, and brain tumors may show similar signs and symptoms. Differentiation of these disorders depends on careful examination of CSF obtained by LP and additional immunological, radiographic and imaging studies. Non-infectious causes of meningitis include medications such as NSAID, trimetheprim-sulfamethaxazole, INH, metronidazole, IVIG treatment, Behcet syndrome, SLE, mixed connective tissue diseases, sarcoidosis, familial mediterranian fever, Vogt-koyonagi syndrome, procedures involving the CNS (neurosurgery, spinal anesthesia, intrathecal injections),subarachnoid hemorrhage, vein of Galen aneurism, mollaret meningitis, intracranial /intraspinal tumors and cysts[25].

2.7 Treatment

Treatment of bacterial meningitis focuses on sterilization of CSF by antibiotics, and maintenance of adequate cerebral and systemic perfusion. Because of increasing resistance of *S. pneumoniae* to both pencillin and cephalosporin, cefotoxime or ceftriaxone should be administrated until antibiotic susceptibility testing is available. 3rd generation cephalosporin are adequate to treat *N. meningitidis* and *H. influenzae* types[8].

For infants <2months ampicillin is added to cover possibility of Listeria and *E. coli*. duration of treatment is 10-14 days for *S. pneumoniae*, 5-7 days for *N. meningitidis* and 7-10 days for *H. influenzae*[8].

Table 2.4 (Empirical antimicrobial therapy for presumed bacterial meningitis [4])

Age	Drug of choice	Alternative drug
0-1 month	Ampicillin+gentamycin	Ampicillin+cefotoxime
Infants and toddlers 1month-4years	Ceftriaxone or cefotoxime+vancomycin	Ampicillin+chloramphenicol
Children and adolescents 5-13years and adults	Ceftriaxone or cefotoxime+vancomycin	Ampicillin+chloramphenicol

2.7.1 Pathogen specific therapy:

1-Group B streptococcus should be treated for at least 2-3weeks.
2-L.monocytogenes should be treated >21days.
3-uncomplicated pencillin sensitive *S. pneuomoniae* should be treated 10-14 days with 3rd generation cephalosporin or iv pencillin G(400000u/kg/24hours given every 4-6hours).
4-uncomplicated *H. influenzae* meningitis should be treated for7-10 days.
5-IV pencillin (400000u/kg/24hours)for 5-7days is treatment of choice for uncomplicated meningitis
6-staphylococcus meningitis should be treated for 2weeks
7-Gram –ve bacillary meningitis should be treated for 3 weeks[11,16,26,27]

2.7.2 General and supportive measures: Children with meningitis are often systemically ill, the following complications should be looked for and treated aggressively: hypovolemia-hypoglycemia-hyponatremia-acidosis-septic shock-increase ICP-seizures -DIC- and metastatic infection(e.g. arthritis, pneumonia or pericarditis) [28].

Monitoring include cardio-respiratory monitoring, strict fluid balance, frequent urine specific gravity assessment, daily weights, neurological assessment every few hours, not fed until neurologically very stable, isolated until the organism is known, rehydrated with isotonic solutions until euvolemic, and then give IV fluid containing dextrose and sodium at no more than maintenance rate(assuming no usual losses occur) [28].

2.7.3 The role of corticosteroids: It's now widely accepted that much of cerebral damage which occurs in bacterial meningitis is not caused by invading organism itself but the host mediated inflammatory response. while number of adjunctive anti-inflammatory agents have been suggested only corticosteroid have been tested in clinical trials. Several studies show some improvement in morbidity (deafness or neurological deficit) although these studies were largely conducted in children with H.influenzae type b meningitis .fewer data are available in children with pneumococcal and meningococcal meningitis regarding the use of corticosteroid[29].

2.8 Complications

2.8.1 Abnormalities of water and electrolyte balance: Result from either excessive or insufficient production of antidiuretic hormone and require careful monitoring and appropriate adjustment in fluid administration. Monitoring serum Na every 8-12 hours during first 1-2 days, and urine sodium if the inappropriate secretion of ADH is suspected, usually uncovers significant problems[28].

2.8.2Seizures: Occur in 20-30% of children with bacterial meningitis. seizures tend to be most common in neonates and less common in older children. Persistent focal seizures are associated with focal neurological deficit strongly suggests subdural effusion, abscess, or vascular lesions such as arterial infarct, cortical venous infarcts or dural sinus thrombosis. Because generalized seizures in a metabolically compromised child may have severe sequelae, early recognition and therapy are critical[28].

2.8.3 Subdural effusion: Occur in up to one third of young children with *S.pneumoniae* meningitis. subdural effusion are often seen on CT scan of the head during the course of meningitis, they don't require treatment unless they are producing increase ICP or progressive mass effect. although it may be detected in children who have persistent fever, such effusions don't have to be sampled or drained if the infecting organism is *H. influenzae*, meningococcus, or pneumococcus. these are usually sterilized with the standard treatment duration and slowly waning fever during an otherwise uncomplicated recovery may be followed clinically. Under any other circumstance, however, aspiration of the fluid for documentation of sterilization or for relief of pressure should be considered. Interestingly prognosis is not worsened by subdural effusion[28].

2.8.4 Cerebral edema: Can participate in production of increase ICP requiring treatment with dexamethasone, osmotic agents, diuretics, or hyperventilation, continuous pressure monitoring may be needed[28].

2.8.5 Long term sequelae of meningitis: Result from direct inflammatory destruction of brain cells, vascular injuries or secondary gliosis. focal motor and sensory deficit, visual impairment, hearing loss, seizures, hydrocephalus, and variety of cranial deficits can result from meningitis. Sensorineural hearing loss in *H. influenzae* meningitis occur in about 5-10% of patients , during long term follow up ,early addition of

dexamethasone to the AB regimen may modestly decrease the risk of hearing loss in some children with meningitis. In addition to the disorders mentioned some patients developed mild to severe cognitive impairment and severe behavioural disorders that limit their function at school and later performance in life[28].

2.9 Prevention

2.9.1 Antibiotic prophylaxis: Close contacts of patients with meningococcal disease should receive chemoprophylaxis with rifampicin (5mg/kg if<1 month ,10mg/kg if>1month, maximum dose 600mg)twice daily for 2 days started ideally within 24 hours of exposure. A single large oral dose of ciprofloxacin (20mg/kg maximum 500mg) or azithromycin(10mg/kg maximum 500mg) or a parenteral dose of ceftriaxone(125mg IM if<15 years, 250mg IM if>15 years) are suitable alternatives. The last is preferred for pregnant women. Rifampicin prophylaxis is also recommended for all house hold contacts of an index case with Hib disease when at least one house hold contact is younger than 4 years and in unimmunized or incompletely immunized[30].

2.9.2 Vaccination: It's the most effective way of preventing bacterial meningitis. meningococcal quadrivalent vaccine against serotype A,C,Y and W135 is recommended for high risk children >2 years include those with anatomic or functional asplenia or deficiency of complement proteins[11,24,31,32].

The impact of conjugate Hib vaccines has been documented extensively. PCV7 tested in large scale trials conducted in USA showed 97% per protocol efficacy against invasive infections caused by pneumococcal serotype contained in the vaccine[33].

A marked reduction of pneumococcal meningitis in vaccinated children in USA has been documented[34,35].

Trial of PCV9 conducted in African children was associated with reduced incidence by 65% to 83%[36].Four Hib conjugated vaccine currently are licensed, all result in protective level of antibody ranging from 70-100%, all children should be immunized with Hib conjugated vaccine beginning at 2 months of age[11].

2.10 Prognosis

The outcome depends on the patient age, duration of illness before initiating effective AB therapy, the type of causative organism, the intensity of the patient's inflammatory response, the number of bacteria or the quality of active bacterial product in CSF at the time of diagnosis and the time need to sterilize the CSF culture[31].

3.0 Patients and Methods

3.1 Study design: This is a prospective descriptive study conducted from 1st of October until 28th of February 2015 in child central teaching hospital looking for clinical presentations and acute complications of meningitis and finding some of the risk factors of those complicated cases with patients age 2months-12years.

3.2 Study sample: Out of 155 child admitted to the child central teaching hospital with a clinical suspicion of meningitis only 117 of them were included as they match the inclusion criteria.

3.3 Inclusion criteria: Patients age 2 months-12 years presented with signs and symptoms suggestive of meningitis(fever , fit, poor feeding, vomiting , lethargy ,altered consciousness , irritability , headache, photophobia ,bulging fontanelle, kernig's sign, brudzinski's sign and neck stiffness) admitted to child central teaching hospital during the period of the study when LP done and it was not traumatic and CSF count of cells more than 5 wbc/mm^3.

*CSF findings include: colour, total cell count(number and type of cells),CSF protein, sugar and culture.

*other investigations: blood culture,CRP, WBC, HB, platelets count, serum Na, Ca, K ,RBS and others.

*gram stain and latex agglutination were not done because of unavailability at that time in our hospital.

*SIADH was diagnosed by:

1- serum Na less than 130
2-oliguria, urine output<20ml/kg/24hrs
3-increase weight more than 10% of body weight.

*Neuroimaging (CT or MRI)was done for:

1-seizures developed 72 hours after treatment
2-Focal neurological signs
3-Continued excessive irritability

4-persistent fever
5-increasing OFC
6-persistent abnormal CSF indices

3.4 Exclusion criteria:

1-patient age less than 2 months because the CSF analysis differ in this age group from older children.
2-when LP was traumatic
3-when LP was not done for any reason.
4-Presence of shunt within the central nervous system.
5- presence of chronic neurological disease(cerebral palsy CP or epilepsy)
6-patients with recurrent meningitis
7-presence of known immunodeficiency.

3.5 Follow up period: All patients were followed up for 1-2 weeks during the hospitalization period to monitor daily (vital signs, OFC, urine output, body weight and neurological deficit).Also, after 1week after discharge looking for any neurological defects, epilepsy, increase OFC.

3.6 Data collection: Data was obtained from the relative of the patient including: name, age, sex, address, date of admission, duration of illness before diagnosis, history of antibiotic use before diagnosis and the presenting symptoms.

3.7 Analysis of data: Analysis of data collected was done by:

1-using descriptive statistics (frequency and percentages).
2-P value was calculated by chi-square test and considered significant when it was less than or equal 0,05.

4.0 Results and Tables

From 117 patients with meningitis who were included in this study 73 patients(62,4%)were males and 44 patients(37,6%) were females with male to female ratio 1,65:1. (table 1) (figure 1).

Table 4.1 (sex distribution of the disease)

Gender	Number	Percentage
Male	73 cases	62,4%
Female	44 cases	37,6%
Total	117 cases	100%

The above table shows that male patients were more than females with ratio 1.65:1.

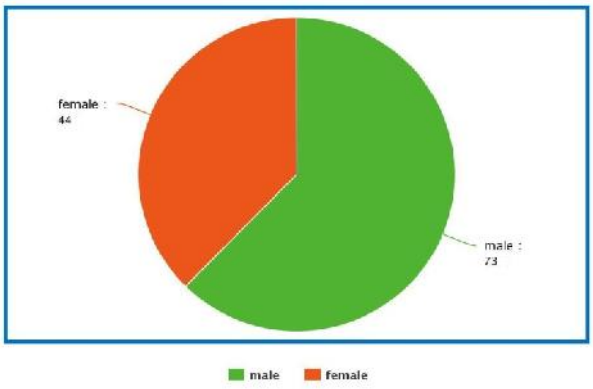

Figure 4.1(sex distribution)

Patients age<1 year were 81(69,2%) and 36 patients(30,8%)were >1 year. (table2) (figure2).

Table 4.2 (Age distribution)

Age	Number	Percentage
Less than 1 year	81 cases	69,2%
More than 1 year	36 cases	30,8%
Total	117 cases	100%

The above table shows most of the patients were below 1 year.

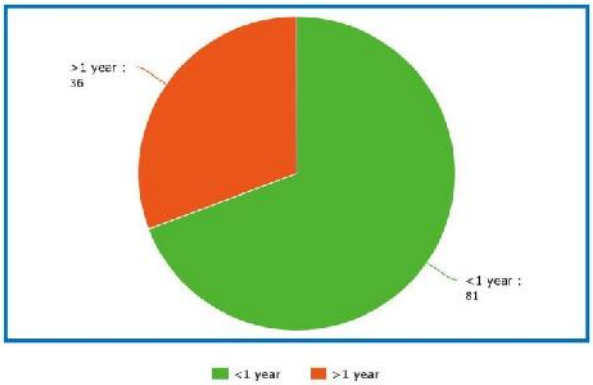

Figure 4.2 (age distribution)

Regarding the presenting symptoms fever was the most common symptom observed in 115 patients (98,2%) followed by convulsion in 76 patients (64,9%). Other symptoms poor feeding 61 patients (52,1%), vomiting 39 patients (33,3%), lethargy 36 patients (30,7%), diarrhea 21 patients (17,9%), irritability 16 patients (13,6%) , altered consciousness 12 patients(10,25%), headache 9 patients (7,6%), and photophobia 4 patients (3,4%). (table 3).

Table 4.3(the presenting symptoms in order of frequency)

Symptom	Number	Percentage
Fever	115	98,2%
Convulsion	76	64,9%
Poor feeding	61	52,1%
Vomiting	39	33,3%
Lethargy	36	30,7%
Diarrhea	21	17,9%
Irritability	16	13,6%
Altered consciousness	12	10,25%
Headache	9	7,6%
Photophobia	4	3,4%

The above table shows that fever was the most common symptom 98,2% followed by fit 64,9%.

Regarding the clinical signs bulging fontanelle was the most common presenting sign found in 45 patients (38,4%) followed by neck stiffness 24 patients(20,5%),Kernig's sign 16 patients(13,6%), Brudzinski's sign 11 patients(9,4%),focal neurological signs 8 patients (6,8%). (table 4).

Table 4.4 (physical signs in order of frequency)

Sign	Number	Percentage
Bulging fontanelle	45	38,4%
Neck stiffness	24	20,5%
Kernig's sign	16	13,6%
Brudzinski's sign	11	9,4%
Focal neurological signs	8	6,8%

The above table shows that bulging fontanelle was the most common sign 38,4% followed by neck stiffness 20,5%.

Table 5 shows the types and percentages of acute complications of the disease. Total number of complicated cases was 38 cases. The repeated convulsions(which occur beyond the 4th hospital day) was the most common complication found in 16 patients(13,6%) followed by subdural effusion 11 patients (9,4%), hydrocephalus 5 patients (4,2%), SIADH was found in 3 patients(2,5%), death 2 patients(1,7%),cranial nerve palsy which was facial palsy noted in 1 patient (0,8%).

Regarding CSF profile there were 103 patients(88,1%)with clear appearance of CSF and it was cloudy in 14 patients(11,9%).while cell count in CSF there were 70 patients<100 cells(59,8%),39 patients (33,3%) from 100-1000 cells and 8 patients (6,9%)>1000 cells.

Table 4.5 (acute complications in order of frequency)

Complication	Number	Percentage
Convulsion	16	13,6%
Subdural effusion	11	9,4%
Hydrocephalus	5	4,2%
SIADH	3	2,5%
Death	2	1,7%
Cranial nerve palsy	1	0,8%

The above table shows that convulsion was the most common acute complication 13,6% followed by subdural effusion 9,4%.

Regarding CSF glucose it was low in 37 patients(31,6%) and normal in 80 patients(68,4%) while CSF protein was high in 39 patients(33,3%) and normal in 78(66,7%). The CSF culture was positive in 5 patients(4,2%)and negative in 112(95,8%).In addition to CSF blood results were positive blood culture in 18 patients(15,4%)and negative in 99(84,6%), while CRP was positive in 78 patients(66,7%) and negative in 39 patients (33,3%). Table (6).

Table 4.6 (the result of CSF examination and some hematological tests).

CSF appearance	Types	Number	Percentage
	Turbid	14	11,9%
	Clear	103	88,1%
CSF leukocyte count	Less than100	70	59,8%
	100-1000	39	33,3%
	More than1000	8	6,9%
CSF glucose	Low	37	31,6%
	Normal	80	68,4%
CSF protein	High	39	33,3%
	Normal	78	66,7%
CSF culture	+VE	5	4,2%
	_VE	112	95,8%
CRP	+VE	78	66,7%
	_VE	39	33,3%
Blood culture	+VE	18	15,4%
Blood culture	_VE	99	84,6%

Regarding risk factors for the complications of meningitis we study the impact of sex on complications and it shows that male gender had significant relation to complications with p value 0.0183.Table(7).

Table 4.7 (impact of sex distribution on complication of meningitis).

Gender	Complications		Total	Chi square	P value
	Yes	No			
Male	30	43	73	5.570	0.0183 statistically significant.
Female	8	36	44		
Total	38	79	117		

The above table shows that male gender had significant prognostic effect and relation to complications of meningitis with P-value less than 0.05.

Also, age<1 year found to have significant relation to complications as p value 0.0264 and it's <0.05. Table(8)

Regarding the impact of clinical presentation on complications of meningitis this study shows that only altered level of consciousness and focal neurological signs have significant relation to complications as p value was<0.05 in both. Table(9)

Table 4.8 (impact of age distribution on complications of meningitis).

Age	Complications		Total	Chi square	P value
	Yes	No			
<1 year	32	49	81	4.933	0.0264 statistically significant.
>1 year	6	30	36		
Total	38	79	117		

The above table shows that patients age less than 1 year had significant prognostic effect and relation to complications of meningitis with p-value less than 0,05.

Table 4.9 (impact of clinical presentation on complications of meningitis) shows that only altered level of consciousness and focal neurological signs have significant value and relation to complications as p value<0,05, table is attached in appendix A.

The impact of duration of symptoms before diagnosis and delay in starting appropriate antibiotics was studied and found to be significant in relation to complications as p value was<0.0001.Table (10).

Table 4.10 (impact of duration of symptoms before diagnosis on complications).

Duration of symptom before diagnosis	Complications		Total	Chi square	P value
	Yes	No		57.624	P value is less than 0.0001 statistically significant.

The above table shows that prolonged duration before diagnosis and delay in starting appropriate treatment have significant effect on complications as p value<0.05.

Tables (A1, A2, A3, A4, A5 and A6) show that positive blood culture, CSF culture and CSF cell count>1000 have significant prognostic effect on complications as p value <0,05.

And lastly the impact of some of the investigations on complications was studied and we found that positive blood culture, positive CSF culture and CSF cell count>1000 all have significant relation to complications as their p value was <0.05. Table (11).

Appendix A.

Table A1

	Complication	No complication	Total	Chi square value	P value
Fever	37	78	115	0.2848	0.59354 This result is *not* significant at p < 0.05.
No fever	1	1	2		
Total	38	79	117		
	Complication	No complication	Total	Chi square value	P value
Poor feeding	15	46	61	3.6164	0.057213 This result is *not* significant at p < 0.05.
No	23	33	56		
Total	38	79	117		
	Complication	No comp	Total	Chi square value	P value
Vomiting	13	26	39	0.0195	0.888979 This result is *not* significant at p < 0.05.
No	25	53	78		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Lethargy	11	25	36	0.0877	0.767133 This result is *not* significant at p < 0.05.
No	27	54	81		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Diarrhea	10	11	21	2.6753	0.101917 This result is *not* significant at p < 0.05.
No	28	68	96		
Total	38	79	117		

Table A2

	Complication	No	Total	Chi square value	P value
Irritability	7	9	16	1.0737	0.300102 This result is *not* significant at p < 0.05.
No	31	70	111		
Total	38	79	117		

Table A3

	Complication	No	Total	Chi square value	P value
Headache	4	5	9	0.6366	0.424954 This result is *not* significant at p < 0.05.
No	34	74	108		
Total	38	79	117		

Table A4

Fit at diagnosis	Complications		Total	Chi square	P value
	Yes	No			
Yes	20	56	76	2.997	0.0834 not statistically significant.
No	18	23	41		
Total	38	79	117		

Table A5

Altered consciousness	Complications		Total	Chi square	P value
	Yes	No			
Yes	11	1	12	18.459	P value is less than 0.0001
No	27	78	105		
Total	38	79	117		

Table A6

	Complication	No	Total	Chi square value	P value
Photophobia	2	2	4	0.5798	0.446398 This result is *not* significant at p < 0.05.
No	36	77	113		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Neck stiffness	10	14	24	1.1623	0.280988 This result is *not* significant at p < 0.05
No	28	65	93		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Kernig's sign positive	8	8	16	2.5947	0.107224 This result is *not* significant at p < 0.05
Negative	30	71	111		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Brudzinski's sign positive	5	6	11	0.9322	0.334292 This result is *not* significant at p < 0.05
Negative	33	73	106		
Total	38	79	117		
	Complication	No	Total	Chi square value	P value
Focal neurological signs	7	1	8	11.8542	0.000575 This result is significant at p < 0.05
No	31	78	109		
Total	38	79	117		

5.0 Discussion

The age and sex of patients were analyzed and found that meningitis is more common in males and more common in children age <1 year.

Similar results regarding the sex were found by Tariq, Raghad and Farag [37,38.39]. while regarding age similar results were found by Tariq and Farag [37,39]and this may be explained by decrease antibodies production against polysaccharide capsular Ag in children<2 years resulting in increased susceptibility to H.influenzae and S.pneumoniae infection. While Raghad found majority of cases>1 year and this is may be due to different inclusion and exclusion criteria[38].

Fever was the most common presenting symptom 98% followed by fit 64%,Tariq also found that fever was the most common symptom 96% followed by vomiting 52% [37], while Raghad found also fever the most common symptom 94% followed by poor feeding65% [38] . Farag found fever in 92% followed by vomiting in 75% [39]. The different results may be due to different sample size between these studies.

Bulging fontanelle was the most common sign 38% followed by neck stiffness 20% while Tariq had same results with bulging fontanelle 49% followed by neck stiffness 23%. [37] Raghad found neck stiffness most common 40% followed by bulging fontanelle 23% and that's because in her study the majority of patients were >1 year so neck stiffness was the most common sign[38].

Regarding complications repeated convulsion was the most common complication 13,6%followed by subdural effusion9,4%.Similar results found repeated convulsion was the most common complication by Tariq, Raghad and Farag with percentages(14%,13% and 7,1%)respectively [37,38,39]. While Namani found subdural effusion was.
the most common complication by 12,6%,the difference may be due to availability of CT scan and MRI in his country[40].

Regarding the prognostic factors male gender was found significant prognostic factor P value 0.018,similar results found by Kooman et al[41] while Alaa Found it not significant P value0,798[42].

Age <1 year was found significant factor P value 0,0246,similar results found by Namani and Alaa , this may be explained by immature immune status in this age group resulting in more severe infections. [40,42]

In this study we found that altered consciousness and focal neurological signs were the only significant presentations regarding complications (0,0001 and 0.0023)respectively. Alaa found same results in her study. [42] while Namani found in addition to altered consciousness and focal neurological signs,fit at the time of diagnosis was significant and this is may be due to his small study sample (77 patients)[40].

In this study patients with prolonged duration of symptoms before diagnosis>5 days were significant regarding complications as P value <0,0001,and this agrees with the results found by Namani, Kooman et al and Alaa who found it significant because poor prognosis occur with delay of starting appropriate AB therapy [40,41,42].

Regarding investigations positive CSF culture,positive blood culture and CSF cell count>1000 cells were found significant prognostic factors as P value (0,0009,0,0001,0,000575) respectively.

Alaa found positive blood culture,CSF cell count>1000, and positive CRP were significant [42],while Namani found only positive blood and CSF culture were significant[40].

6.0 Conclusion

1-Meningitis is one of the most serious infections that cause high rate of morbidity and mortality.

2-Male gender, age< 1 year have more incidence of meningitis.

3-Fever was the most common presenting symptom,bulging fontanelle was the most common presenting sign,and convulsions was the most common acute complication.

4-Male gender,age <1 year,altered level of consciousness, focal neurological signs, prolonged duration of symptoms>5 days before diagnosis, positive blood culture,positive CSF culture and CSF cell count>1000 cells all were found to be important prognostic factors regarding complications.

5-Early diagnosis and prompt treatment have a great effect on outcome in majority of the cases.

7.0 Recommendations

1-high index of suspicion for early diagnosis of meningitis when we have signs and symptoms suggestive for it.

2-Improving laboratory work and availability of CT and MRI for early detection of complications.

3-Careful follow up for patients to detect any possible complication and treat it accordingly.

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