Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [4] November 2022 : 389-395

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

To Study Inflammatory and Infectious Disorder of the Brain - Meningitis

Parul Sharma[1], Shweta Sharma[2*]
Assistant Professor, Department of Physiotherapy, Delhi Pharmaceutical Sciences& Research University, New Delhi
Assistant Professor, Faculty of Physiotherapy, SGT University, Gurugram
***Corresponding author Email**: shwetasharmampth27@gmail.com

ABSTRACT
Meningitis is a medical emergency requiring immediate diagnosis and immediate treatment. Early diagnosis and rapid initiation of empiric antimicrobial and adjunctive therapy are vital. Therapy should be initiated as soon as blood cultures have been obtained, preceding any imaging studies. Emerging antibiotic resistance is an upcoming challenge. In this chapter, we review the pathophysiology, clinical features, diagnosis, medical and therapeutic treatment strategies. Interventions for meningitis include prompt diagnosis & initiation of antimicrobial therapy to decrease inflammatory response in the subarachnoid space. Effective Management consists of effective delivery of antibiotic therapy, fluid management, supportive care & physiotherapy.
Keywords: *Meningitis, Clinical features, Pathophysiology, Medical & therapeutic management*

Received 12.10.2022 Revised 23.10.2022 Accepted 21.11.2022

INTRODUCTION

Inflammation of membranes of spinal cord and brain i.e. Piamater, arachnoid mater and duramater.

Epidemiology

Incidence of pyogenic meningitis has gone down with invention of antibiotics, however , mortality is still upto 50%. The causative organisms are:

a) Neonates- e. Coli, streptococci
b) Infants / children: h. Influenza
c) Adolescents/ young adults: n. Meningitis
d) Elderly: s. Pneumonia, listeria monocytogenes.
e) Pseudomonas, kleibseilla, e.coli, staphylococcus are the main causative organisms in surgical cases or lumbar puncture.
f) Pseudomonas, kleibseilla, e.Coli and staphylococcus are the main causative organisms in cases of head injury or accidental injuries.

Mode of spread-

a) Commenest mode of spread : haematogenous
b) Direct spread: from paranasal sinuses, sinusitis, otitis media, fracture of base of skull or in neonates at the time of delivery.[1]

Factors of responsible for spread of pyogenic meningitis:

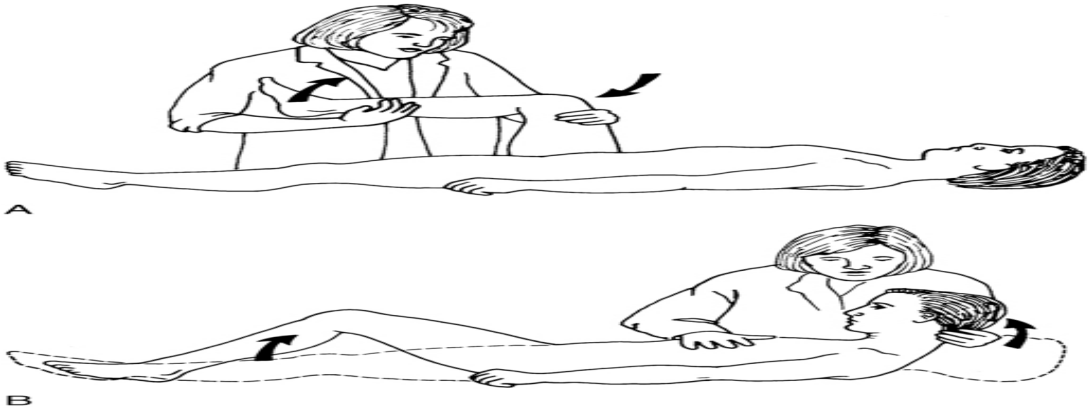
1) Host:
   a. Extremes of age- very young or very old
   b. More commonly in males
   c. Immature host defense mechanism which leads to severe infection, as for e.g. Malnutrition, alcoholism, diabetes, chest infection etc.
2) Bacteria: It will depend on virulence of micro-organism. These organisms first colonisenaso-pharynx and then enter CNS through vulnerable sites and blood brain barrier.
3) Environmental factors: meningococcal meningitis is more commonly seen in densely populated areas. Other factors are pollution and less sunlight in slum areas etc.

Pathology:

In early stages, there is congestion of cerebral and pia blood vessels. Later on, exudate appears which is creamy, purulent material that fills the basal cistern and sulci. Arachnoid is stretched, exudate is seen in ventricles, subarachnoid space and spinal cord and is diffuse.[2]

Bedside Diagnostic Tests-

- The Kernig sign refers to a test performed with the client supine in which the thigh is flexed on the abdomen and the knee extended (Figure A). Complaints of lumbar or posterior thigh pain indicate a positive test result. This movement pulls on the sciatic nerve, which pulls on the covering of the spinal cord, causing pain in the presence of meningeal irritation. The same results are achieved with passive hip flexion with the knee remaining in extension. This is the same procedure described by Hoppenfeld as the straight leg raising test for determining pathology of the sciatic nerve or tightness of the hamstrings. Passive hip flexion with knee extension can be painful because of meningeal irritation, spinal root impingement, sciatic nerve irritation, or hamstring tightness.
- The Brudzinski sign refers to the flexion of the hips and knees elicited when cervical flexion is performed (Figure B). These signs will not be present in the deeply comatose client who has decreased muscle tone and absence of muscle reflexes. The signs may also be absent in the infant or elderly patient. Finally, the jolt test, which has the patient turn his or her head from side to side quickly (two to three rotations per second), has a positive result if the maneuver worsens the patient's headache.[3]



Microscopic examination:

The exudate consists of mainly polymorphs, few lymphocytes and plasma fibrin bacteria. Blood vessels are engorged, thrombosed and even ruptured. Brain shows ventriculitis and vasculitis and petechial haemorrhage, infarction, hydrocephalus and abscess formation may be seen in later stages.

Clinical features:

a. Headache
b. Nausea
c. Vomiting

Symptoms related to infections such as:

a) Tachycardia
b) Tachypnea
c) Malaise
d) Hyperpyrexia

Specific signs and symptoms:

a. Pain and stiffness of neck
b. Positive kernig's sign
c. Photophobia
d. Irritability

Other symptoms: confusions, hallucinations, fits (local or general)Cranial nerve involvement: 3rd, 4th and 6th are the most common. Sphincter paralysis, incontinence, altered vital signs like irregular pulse, low B.P., hyperpyrexia and coma, ultimately death occurs in terminal stages of meningitis. Fever, diarrhoea, vomiting, anorexia, respiratory distress, irritability and bulging fontanelle may be seen.

Diagnosis:

1) Lumbar puncture: shows purulent cerebrospinal fluid. Fluid is turbid for cells and sugar. Fluid contains
   a) Increased number of cells:
      < 50/ um^3 - mild meningitis
      50- 200 / um^3- moderate meningitis
      >200/ um^3- severe meningitis
      > 1000/um^3- diagnostic

Sometimes upto 50,000/um^3, most of cells are polymorphs upto 90% with some lymphocytes.

b) Decreased sugar level upto 8-10 mg%
c) Increased proteins upto 75%

2) Gram staining and culture is done for identification of micro-organisms.
3) Nuchal rigidity is indicative of irritable lesion of sub-arachnoid space.
4) Cervical flexion is painful because its stretches inflamed meninges, nerve roots and spinal cord. Several clinical tests are done to demonstrate nuchal rigidity.
5) Kernig's sign- patient is in supine position with cervical flexion and thigh flexed on abdomen with knee extended. This pulls on sciatic nerve which pulls on covering of spinal cord causing pain in presence of meningeal irritation. So, sign of pain indicates positive test.[4]

Complications:

Can be due to: Septicaemia and CNS involvement.

Early complications:

a) Aphasia
b) Hemiplegia
c) Blindness
d) Seizures
e) Cranial nerve palsies

Late complications:

a) Paraplegia
b) Hydrocephalus
c) Palsies of 6th, 7th and 8th cranial nerve
d) Recurrent fever
e) Subdural haematoma

Due to septicaemia, there may be:

a) Pneumonia
b) Endocarditis
c) Phlebitis
d) Arthritis
e) Diabetes insipidus[5]

Medical management:

Medical management consists of initiation of antimicrobial regimen appropriate to the infective organism.

1) If unknown etiology- start with penicillin (2-3 lac iu/kg/day , 2hourly x 10-14 days)
2) Chloramphenicol is also recommended – (100 mg/day x 4 doses- 10-14 days)
3) For pneumococcal and meningococcal meningitis – same treatment as above can be recommended.
4) If gram –vee.coli is suspected: neonatal ampicillin (100-200 mg/kg/day) and gentamycin (5mg/kg/day) are recommended.
5) Post traumatic: ampicillin and chloromycitin are recommended for 1 month.
6) H. Influenza: ampicillin and ceftriaxone are recommended.
7) Staph. Aureus: mafcillil (100-200mg/kg/day) for 2 weeks should be recommended.[6]

Tubercular meningitis:

Causative organism: mycobacterium tuberculi. It is secondary to remote 1st degree infection and spread is haematogeneous.

Stage I – lesion in brain/ meninges from blood borne tubercular bacilli usually from 1st degree site of infection, e.g.- lung/ abdomen

Stage II - there is discharge of bacilli and tubercular antigen from focus, immediately after focus is formed or it can take months or years. This caseous lesion may be in spinal cord and may spread to CNS as tubercular meningitis. Rarely, it may spread from tubercular spondylitis, tubercular otitis or tubercular osteitis.

Severity of illness depends on 3 factors:

a) Number of bacilli
b) Their virulence
c) Immune response of host

So, if bacilli are small in number and resistance of host is good, infection is localized.

Pathology:

Hallmark of the whole disease process is exudate formation which is extensive in nature. It is thick in basal cisterns and strangulates cranial nerves and blood vessels at base of brain. Exudate may occlude Foramen of Magendie or Luschka and may spread over frontal lobes.[7]

Microscopic examination:
Exudates consists of fibroblasts, lymphocytes, polymorphs, epitheloid cells and giant cells. This spreads along pial blood vessels into perivascular space and produce tuberculomas which are small to very big size and seen in 50% of cases. Exudate if present in choroid plexus may cause ependymitis.
Blood vessel changes/vasculitic changes: vary from occluded blood vessels to vasculitis. Vasculitis is present in all cases of tubercular meningitis. There is periarteritis and intima proliferation which narrows the lumen of blood vessels. Panarteritis may also be seen. Middle cerebral artery and anterior cerebral artery are commonly engorged. If veins are affected , phlebitis and thrombosis may also be seen.
Clinical features:
Signs and symptoms develop slowly and they may be correlated with pathological changes.

a) **Prodromal stage**: lasts upto 3 weeks in a child. Apathy , irritability, restlessness anorexia, vomiting, pain in abdomen and child may not be interested in usual activities like playing games. In adults, depression, behavioural changes, psychosis and confusion may be seen.
b) **Start of illness**:tubercular meningitis starts low grade fever, neck rigidity, headache , vomiting, positive kernig's sign and altered sensorium. Cranial nerves involvement is there- 2nd, 3rd, 4th, 6th, 7th and 8th. Hemiplegia, aphasia and seizures can also seen in later stages.
c) **Advanced cases**: quadriparesistural / quadriplegia can be seen . In children, sutural diastasis, decerbration and herniation followed by death.
d) **Spinal tubercular meningitis**: radiculomyelopathy is seen.

Diagnosis: There is no definite criteria

1) Mantoux test may be positive.
2) Lumbar puncture:

a. Cerebrospinal fluid shows turbid fluid, cob web develops in 5-6 hours in test tube which is very helpful in detecting afb.
b. Elevated proteins
c. Sugar is low: 20-40mg%
d. Cells: depend on stage of disease. Usually vary from 40-1000/mm^3

3) AFB culture
4) Polymerase chain reaction
5) Elisa test

Management:
1st line drugs:

a) Streptomycin
b) Isoniazid
c) Rifampicin
d) Pyridoxine
e) Pyrazinamide
f) Thiacetazone
g) Ethambutol

2nd line drugs:

a) Ethionamide
b) Cycloserine
c) Prednisolone

- Surgery is done for hydrocephalus and tuberculoma, if not resolved with drugs.
- Cyst is excised in case of tubercular arachnoiditis.

Prognosis:

1) Earlier the treatment given, better the prognosis
2) Outcome varies from total recovery to no response at all.
3) 30% of patients are left with significant sequale, for e.g.- optic atrophy and blindness.[8]

Aseptic/viral meningitis:
It is manifested by increased signs and symptoms and increased cells in csf but no bacteria in culture. It is caused by enterovirus, mumps, lymphocytic choreomeningitis and post vaccinial.
Milder infections can also be caused by encephalitis producing virus (arbo and hsv). In 30% cases, the cause is unknown.

Clinical features:
Stage 1: Viraemic Stage: fever, headache, bodyache and respiratory symptoms.
Stage 2: Meningitic Stage: severe headache, vomiting, neck stiffness, positive kernig sign and drowsiness.
Investigations:

a. Cerebrospinal fluid examination shows: increased number of cells, increased proteins and normal sugar.
b. Virus isolation from cerebrospinal fluid.
c. Increased antibody titre (4 times or more in 4 weeks)
d. No focal signs are present
e. Recovery takes place in 7-10 days without any specific treatment.[9]

Rehabilitation:

Examination and evaluation process

Designing an individualized intervention program based on patient's problems necessitates a comprehensive initial and ongoing evaluation to define the impairments, functional limitations, disabilities and to note changes in them.

Most critical to final outcome is the determination of level of consciousness before, during and after a particular intervention technique to determine its impact on individual's level of arousal and ability to interact with the environment.

1) Observation of current functional status

1st step in evaluation process is observation of patient's current functional status.If the patient is comatose and non-mobile, the focus of initial session may be in: level of consciousness, response to sensory input and joint mobility. If the patient is an outpatient with motor control deficits, the initial session may focus on defining motor abilities and level of consciousness. This provides an initial overview of patient assets and deficits.

1) Status of physiological functions:
   a. Onset of examination or intervention
   b. Assessment of standard vital signs: heart rate, blood pressure, respiratory rate.
   c. Assessment of other indications: ability to clear airway, autonomic responses to position changes, endurance perceived, exertion and dyspnea etc.
2) Cognitive status: assessment of level of consciousness, communication ability, orientation to (time, place, person, situation) , factors that influence motivation, perceptual abilities, explicit learning (declarative memory), implicit learning (procedural memory)
3) Sensory integrity:peripheral sensory information, cutaneous (light, touch, pressure, pain, temperature) , proprioception, kinesthesia) , cortical sensory processing (sharp/ dull, stereognosis, tactile localization, textile, 2 point discrimination) , cranial nerve sensory information (auditory, gustatory, olfactory, visual , vestibular)
4) Movement abilities: assessment of ability to assume, maintain, move within and move out of various postures. Control of head, trunk and limit movements, stereotypical movements, posture, equilibrium, righting reactions, functional muscle stimulation, power and endurance, functional range of motion and joint integrity.
5) Functional abilities: assessment of basic activities of daily livings, preferred postures during tasks, motor planning, adaptive skills, dexterity, coordination and agility, progress on through functional sequence, observation of response to non-routine occurrences.
6) Other assessment:like eating sequence, self-care, home management skills, oro-motor assessment, community and work integration etc.

Goals:

Before setting goals 1st step is to establish 2 tasks:

a) Dealing with specific problem like impairment, functional, limitation, disabilities from which patient is encountering.
b) Dealing with patients assets (positive data) obtained from evaluation process.

Goals of therapeutic intervention program for patients with inflammatory CNS disorders:

1) Postural control is optimized (as demonstrated by ability to maintain a position against gravity with the ability to automatically adjust before and continuously during movement).
2) Selective voluntary movement patterns within functional activities are optimized.
3) Performance of functional activities is enhanced.
4) Integration of sensory information
5) Cognitive status and psychosocial responses are optimized.[10]

Therapeutic interventions:

1) Improving postural control: Optimization of postural set includes concepts of decreasing muscle activity that is too high to allow the performance of movement sequencies as well as augmenting activation that is too low to support the accomplishment of a movement sequence. The postural

set of a patient can fluctuate between degrees of hyper and hypotonicity. The desired outcome is to achieve optimum postural set for a particular movement. Optimal postural control is defined by 2 elements:

a) Patient should have ability to maintain a posture position against gravity and in presence of external perturbations. Automatic adjustment is postural set should occur in anticipation of which continuously during movement.
b) Patient with neurological sequale may exhibit primitive reflexes or stereotypical motor responses that resemble the reflex responses that are present in the process of typical developmental sequence. The utilization of these stereotypical reflexes at part of intervention technique for patients who have limited ability to perform motor responses is controversial. These reflex linkages can be used to augment a response such as turning the head to right to augment an extension response of the right upper extremity (ATNR). If the movement response is elicited through a primitive reflex therapist should immediately attempt to elicit a response without the reflex input. Shaping the sequence in this manner promotes the learning of desired response and not re-inforcement of an undesirable stimulus to achieve the response.

   For e.g. If ATNR is used to elicit triceps function , the head should be returned to neutral position and function augmented by other means such as tapping or other proprioceptive inputs. Once the triceps response is achieved with the head in neutral position, the head should be rotated away from the side of triceps. This promotes a functional response against the influence of a sensory trigger for a stereotypical pattern.

c) For hypertonicity: Vestibular input that is slow and rhythmical may promote a generalized relaxation of skeletal muscle activity. In some patients, trunk remain stiff in movement sequences in which a segmental response between upper and lower trunk should occur. Repetition of rhythmical movement in side lying in which the therapist gently and progressively stretches patient's pelvis in one direction around body axis while moving shoulder girdle in opposite direction and then reverses the movement may effectively alter the biomechanical and neurological contributions to the stiffness. Ankle foot orthosis may alter individuals need to rigidity control the position of pelvis to remain upright. A soft webbing thumb loop to alter the resting position of 1st metacarpal may change the overactivity of muscles throughout upper extremity.
d) The therapist may use handling techniques to change the alignment relationship of body segments before attempting to establish automatic postural adjustments. The therapist imposes control so that the patient can move. As the patient moves and gains control of movement, the therapist lessens the amount of control. The therapist's goal should be to remove his/her hands from controlling the patient's responses.
e) If the patient is alert and understands direction, the therapist should direct the patient to focus on the effects of movement responses rather than focusing attention on the movement of the body. As the patient begins to notice consequences, he/she should be asked to assist in maintaining the changes that promote the more skillful movement response.
f) For hypotonia: Temporary improvement postural responses may occur by providing vestibular input that is called rapid and irregular change. Approximation can be effective in improving the posture with other proprioceptive techniques such as quick stretch or tapping(although the changes evoked by these techniques may be of short duration , the movement components that occur provide the opportunity to individual to learn from the movement).
g) Selective voluntary movement patterns within functional activities are optimized: Quality selective voluntary movement patterns are needed within the framework of functional activities rather than as isolated and abstract movements. Optimization of selective movement patterns may require a decrease in stereotypical movements and increase inability to selectively activate certain muscle groups.
h) Development of ability to execute movements in different postures:The person should be able to perform both mobility and stability patterns with extremity. Patient who exhibit stereotypical posturing of upper extremity with restricted available movement patterns require intervention to change initial position of extremity before movements are attempted. If spasticity is interfering with repositioning of extremity, approximation can be helpful. The therapist's manual contacts for application of approximation force are on weight bearing surfaces of hands. If the flexed position of wrist prohibits application of force to the heel of palm, the approximation can be applied gradually through the fisted hands. As the resistance to passive movement diminishes or decreases, the wrist can be moved towards neutral position so that the therapist can apply approximation through the heel of palm. The patient is asked to assist the therapist with the movement with a minimum effort as overactivation of muscle groups may aggravate the underlying spasticity.

i) Electrical stimulation can be used as an adjunct to facilitate performance of a particular component of a mobility pattern.
j) Electromyography- biofeedback can be a useful modality.
k) Proprioceptive neuromuscular facilitation techniques as approximation and rolling can be used.
l) Performance of functional activities should be enhanced: As the patient develops more appropriate postural control and ability to perform selective more patterns within the functional activities, he/she is developing the basis to perform increasingly challenging functional activities. The intervention strategy must focus on the quality of patient's ability to assume a posture, maintain the posture, move within the posture and move out of posture. The therapist can change the sequence of this progression of activities to meet the needs of patients. The patient may achieve independence in maintaining posture while still requiring assistance in assuming the posture. With infants, the therapist may choose to use the developmental sequence as a general model for functional activities, progression and it should be viewed as a dynamic process so that the intervention incorporates movement both within and between the postures. For others, the focus should be on age appropriate functional activities essential to the individual's daily life such as bed mobility, sit to stand, stand to sit, ambulation, reaching and manipulation.
m) Integration of sensory information: Before the therapist expects the patient to exhibit adaptive behavior to the potential bombardment of input from combinations of cutaneous, proprioceptive, auditory and visual input, the therapist must assess the patient's ability to respond to multisensory inputs. The ability to respond adaptively progresses from a response to a single sensory input > to a response to input in presence of multiple system input> response is based on inputs from 2 or more sources. The patient may response to handling techniques providing proprioceptive and cutaneous cues but may demonstrate a deterioration of performance when auditory cues is added. When verbal cues are added, the therapist should follow the principle that the commands should be concise and appropriately timed.[11]

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest. The research received no specific grant from any funding agency in the public, community, or non-for profit sectors.

REFERENCES

1. Stefan Hahnel, Inflammatory Diseases of the Meninges, 2012 Jun 21: 127–137.
2. Mook-Kanamori BB, Geldhoff M, van der Poll T, van de Beek D. Pathogenesis and pathophysiology of pneumococcal meningitis. Clinical microbiology reviews. 2011 Jul;24(3):557-91.
3. Mehndiratta M, Nayak R, Garg H, Kumar M, Pandey S. Appraisal of Kernig's and Brudzinski's sign in meningitis. Annals of Indian Academy of Neurology. 2012 Oct;15(4):287.
4. Mohan S, Jain KK, Arabi M, Shah GV. Imaging of meningitis and ventriculitis. Neuroimaging Clinics. 2012 Nov 1;22(4):557-83.
5. Joseph L,Andrea G and William A. F., Central Nervous System Infections, Textbook of Neurointensive Care. 2013 May 7 : 427–517
6. Griffiths MJ, McGill F, Solomon T. Management of acute meningitis. Clinical Medicine. 2018 Apr;18(2):164.
7. Valori H. Slane& Chandrashekhar G. Unakal, Tuberculous Meningitis, National library of medicine, May 8, 2022.
8. Pasco PM. Diagnostic features of tuberculous meningitis: a cross-sectional study. BMC research notes. 2012 Dec;5(1):1-6.
9. Hersimran K, Elodie M. B., Thomas B. P., Aseptic Meningitis, National library of medicine, May 29, 2022.
10. Judith A. D., Inflammatory and infectious disorders of the brain, Musculoskeletal Key.
11. Menigitis, Physiopedia, https://www.physio-pedia.com/Meningitis

CITATION OF THIS ARTICLE

P Sharma, S Sharma, To Study Inflammatory and Infectious Disorder of the Brain -Meningitis, Bull. Env.Pharmacol. Life Sci., Spl Issue [4]: 2022: 389-395