**Bacterial Meningitis**

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Meningitis is the clinical condition when the meninges undergo inflammation due to severe infection. Meninges can be defined as the membranes surrounding the brain and spinal cord. To be specific, meningitis occurs due to infection of the subarachnoid space filled with cerebrospinal fluid (CSF). Due to close relationship of the CSF and the brain tissue, meningitis can also include the parenchyma as well as the brain cortex. (Diederik van de Beek, 2016) Classic symptoms of meningitis include neck stiffness, fever and headaches. Owing to the sensitive nature of the nervous system tissue, a chronic inflammation of the meninges incidentally leads to several other clinical aberrations. Prognosis of meningitis, if left untreated, can hence prove to be fatal within a few days. Meningitis is primarily caused by viral infection, but other causes are bacterial or fungal infection. Bacterial meningitis is when the CSF is infected by bacteria that have already infiltrated the circulatory system. Causative bacterial species majorly associated with bacterial meningitis include *Streptococcus pneumoniae, Neisseria meningitidis, Streptococcus agalactiae, Listeria monocytogenes, Staphylococcus aureus* and *Hemophilus influenzae.*

**Treatment:**

The primary approach adopted for the treatment of bacterial meningitis is elimination of the infectious bacterial species. It is therefore based on an antibiotic treatment. Antibiotics are prescribe in the form of a regimen that can normally extend to two weeks. These drugs can be administered intravenously and also given through bolus administration. This treatment can then be categorized into two types: empiric or specific antibiotic treatment. (D. van de Beek, 2016)

The empiric antibiotic treatment depends on the patient age and what geological region the patient belongs to. If the patient belongs to an area where susceptibility to *Streptococcus pneumoniae* is more than normal, the antibiotic prescribed will be different. Since the bacterial specie most commonly accredited to bacterial meningitis is *Streptococcus pneumoniae,* the antibiotic is also one that caters to this specie. However, in adults above 50 where a risk factor for *Listeria monocytogenes* may exist, a different antibiotic treatment is used. This type of antibiotic treatment is recommended if the identification of the causative agent is proving to be difficult or problematic. Some patients can be culture negative and one cannot identify the root cause of the infection from samples taken from patient. In this case, generally a two-week regimen of empiric antibiotics is recommended.

Specific antibiotic treatment can be prescribed if the causative bacterial specie can be identified. This is done after the exact identification of the bacterial species responsible for that case of meningitis by antibiotic susceptibility testing or via identification of bacterial culture obtained from the patient. For *Streptococcus pneumoniae*, the drug used is amoxicillin or ampicillin and ceftriaxone. This is the species with the greatest number of cases so its variations in bacterial meningitis are also several. If the bacteria responsible are resistant to cephalosporin, the antibiotics used must be changed to vancomycin and rifampicin. For *Neisseria meningitidis*, the prescribed drugs are penicillin or amoxicillin. For *Listeria monocytogenes*, the antibiotic used for specific treatment is amoxicillin or penicillin G. For *Hemophilus influenzae*, the drugs used are amoxicillin or ceftriaxone. To treat bacterial meningitis caused by *Staphylococcus aureus,* the common protocol is to use flucloxacillin or vancomycin.

However, other treatment options are also employed in addition to antibiotic administration. The most widely accepted method for the adjunctive treatment of bacterial meningitis is the dexamethasone treatment. This treatment is based on the idea that the effect of meningitis is as severe as the inflammation in the meninges. (BB Mook-Kanamori, 2011) Therefore, immunological modulation can reduce the mortality of the disease and effectively help the ongoing antibiotic treatment. Dexamethasone is a corticosteroid and is hence used for this purpose. There is clear indication of relief via dexamethasone in bacterial meningitis caused by *Streptococcus pneumoniae* and there is dispute on using this treatment for causative species other than this one. Some studies prove that the use of dexamethasone reduces neurologic sequelae from bacterial meningitis of all causative species. (MC Brouwer, 2013)

Other adjunctive treatment methods include the use of osmotic agents to reduce and control the cranial pressure. Paracetamol also improves prognosis of the disease by controlling inflammation and reducing fever. In several cases, monitoring the intracranial pressure can be lifesaving.

One other adjunctive therapy method associated with diet is the use of ketogenic diets in patients with the idea that this diet will increase energy provision to the brain and decrease mortality rates. This can also lead to reduced neurological sequelae after the meningitis has been treated. (Jiaying Feng, 2016)

Therefore, there are several drugs prescribed and used for the treatment of bacterial meningitis and surgery is not a viable option for treatment since this disease is about inflammation of membranes in the central nervous system. Moreover, the influence of diet on the incident of bacterial meningitis is also irrelevant since this is an infectious disease and its treatment and cure is primarily related to elimination of the species causing the infection.

**Prevention:**

The primary method of prevention of an incident of bacterial meningitis is simply by administration of vaccines for the bacterial species that could subsequently lead to an episode of bacterial meningitis. Some patients can have a greater susceptibility to bacterial meningitis as compared to other patients. This can primarily happen because of continuous exposure to a patient with bacterial meningitis. Therefore, preventative measures are intensely recommended for family members of a bacterial meningitis patient. Moreover, genetic susceptibility factors to certain bacterial species that can cause bacterial meningitis can also prove to be a major incentive to undergo preventative methods to ensure that the morbidity and mortality that bacterial meningitis brings can be avoided. There can also be prior physical susceptibility factors (for example, leak of cerebrospinal fluid owing to injury or surgery). Prevention is unquestionable in this case as well.

There is evidence to prove that the risk of contracting bacterial meningitis increases 400-800-fold when a family member becomes a patient. (TA Zalmanovici, 2013) In order to control this risk, antibiotics can be provided as a preventative measure. The prophylactic antibodies most commonly used in this case are ciprofloxacin and rifampicin.

Vaccines are, however, the most potent preventative measure. Conjugate vaccines are commonly used for this purpose as their discovery and increased use for bacterial meningitis is what has brought the global disease rates down. (NG Martin, 2014) A conjugate vaccine can be defined as a vaccine that has an additional polypeptide attached to the purified polysaccharide of the bacterial capsule. This leads to an immunological response that is much more profound and effective than one brought about by a normal vaccine for that bacterial specie. The type of vaccines used for bacterial meningitis caused by *Streptococcus pneumoniae* is called the Pneumococcal conjugate vaccines or PCV. For other causative bacterial species leading to bacterial meningitis, Meningococcal conjugate vaccines are used for *Neisseria meningitidis* while Hemophilus conjugate vaccines are used for bacterial meningitis caused by *Hemophilus influenzae*. (Fiona McGill, 2016)

The recurrence of meningitis is a rare but possible cause of worry. Generally, the chances of meningitis returning to a patient are around 5%. Therefore, although bacterial meningitis can be completely treated, it does leave several neurological sequelae in the form of hearing loss or other vital brain functions. The chance of recurrence, no matter how small, is still a cause of alarm. Therefore, in treated patients of bacterial meningitis as well, vaccination comes highly recommended. (D. van de Beek, 2016)

# References

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