CONDITION

Gram-negative meningitis

Gram-negative meningitis is a serious infection of the membranes surrounding the brain and spinal cord caused by certain bacteria.

WHAT IT IS
Bacterial infection around the brain and spinal cord

BODY SYSTEM
Nervous system

MAIN SYMPTOMS
Fever, severe headache, stiff neck, confusion

WHAT CAUSES IT
Infection with Gram-negative bacteria

HOW IT IS DIAGNOSED
Spinal fluid testing and cultures

MAIN TREATMENT
Intravenous antibiotics and hospital supportive care

CAN IT BE CURED?
Yes - antibiotics can clear infection

IS IT AN EMERGENCY?
Yes - suspected bacterial meningitis needs immediate treatment

LONG-TERM OUTLOOK
Recovery ranges from full to lasting neurological disability

Overview

Gram-negative meningitis is an infection of the meninges, the thin tissues surrounding the brain and spinal cord. It is caused by bacteria described as Gram-negative because of how they appear during a laboratory staining test.

These bacteria include Escherichia coli (E. coli), Klebsiella , Pseudomonas aeruginosa and Acinetobacter . "Gram-negative" identifies a broad group and does not indicate how serious an individual infection will be.

The condition is less common than some other forms of bacterial meningitis. It may occur in newborns, particularly due to E. coli . In older children and adults, it is more often associated with brain or spinal surgery, head injury, leakage of fluid from around the brain, or an implanted device such as a cerebrospinal fluid shunt.

Gram-negative meningitis is a medical emergency. Bacteria can multiply quickly in the fluid around the brain and spinal cord, causing inflammation and raised pressure inside the skull. Treatment usually starts before every test result is available because delays increase the risk of serious complications.

Symptoms

Symptoms may develop over several hours or a few days. They do not always occur together.

Common symptoms in older children and adults include:

A rash is not a defining feature of Gram-negative meningitis, and its absence does not rule out the condition.

After brain or spinal surgery, signs may include fever, increasing confusion, worsening headache, wound drainage, or redness and tenderness along an implanted shunt. A shunt is a tube that drains excess fluid from the brain.

Newborns and young babies may not develop a stiff neck. Signs include poor feeding, unusual sleepiness, irritability, vomiting, breathing changes, an abnormal temperature, seizures or a bulging soft spot on the head. A baby may be difficult to wake or comfort.

Older adults and people with weakened immune systems may have little or no fever or neck stiffness. A new change in alertness or behaviour can be important.

- Fever
- Severe or worsening headache
- Neck stiffness or pain when moving the neck
- Confusion, unusual sleepiness or reduced alertness
- Nausea or vomiting
- Sensitivity to bright light
- Seizures

Causes and risk factors

Gram-negative meningitis develops when bacteria reach the meninges or cerebrospinal fluid (CSF), the clear fluid surrounding the brain and spinal cord.

Bacteria may spread through the bloodstream from another infection. They can also enter directly after surgery, a penetrating head injury, or through an infected neurological device.

Risk factors include:

Having a risk factor does not mean meningitis will occur. Most people with a shunt or recent surgery do not develop it.

Gram-negative meningitis is not usually spread through ordinary social contact. Unlike meningococcal meningitis, infections caused by bacteria such as E. coli or Pseudomonas generally do not require preventive antibiotics like amoxicillin or doxycycline for household contacts.

- Being a newborn, especially if born early or seriously unwell
- Recent brain or spinal surgery
- A head injury that creates an opening into the skull
- A CSF shunt, drain or other neurological device
- A CSF leak through the nose, ear or a wound
- A bloodstream infection caused by Gram-negative bacteria
- A weakened immune system
- Prolonged hospital or intensive care treatment

Diagnosis

Diagnosis requires urgent medical assessment. Symptoms alone cannot identify the responsible bacterium.

A lumbar puncture, or spinal tap, is usually central to diagnosis. A clinician inserts a needle into the lower back to collect CSF. The sample is checked for inflammation, protein and glucose levels, bacteria, and bacterial growth in a culture. Molecular tests may detect bacterial genetic material.

Culture can identify the bacterium and show which antibiotics are likely to work. This is important because some Gram-negative bacteria resist multiple antibiotics. Blood cultures are also usually taken.

A CT scan may be needed before lumbar puncture if there are concerns about raised pressure inside the skull, new weakness, certain seizure patterns or another reason the procedure may be unsafe. Imaging alone does not confirm meningitis, and necessary scanning should not delay antibiotics.

If a shunt or drain may be infected, specialists may collect fluid from it. Further imaging can look for an abscess, blocked CSF flow or infection of the brain's fluid-filled spaces.

Treatment and management

Gram-negative meningitis is treated in hospital with antibiotics given into a vein. Treatment begins as soon as bacterial meningitis is suspected, often before the responsible bacterium is known.

Initial antibiotic choices depend on age, recent surgery, the likely source and local resistance patterns. Once culture and sensitivity results are available, treatment can be adjusted to target the bacterium.

Treatment length varies according to the bacterium, response, repeat test results, complications and whether infected hardware remains. Care may involve infectious diseases, neurology, neurosurgery and intensive care teams.

An infected shunt, drain or other device may need removal or replacement because antibiotics may not clear bacteria attached to hardware. A temporary drain may be used until the infection is controlled.

For difficult healthcare-associated infections, antibiotics may occasionally be delivered directly into the brain's fluid spaces. Specialists generally consider this when bacteria are highly resistant or intravenous treatment is not working adequately.

Supportive care may include fluids, oxygen, seizure treatment and monitoring of blood pressure, kidney function and pressure inside the skull. Rehabilitation may begin if the infection affects movement, speech, hearing, memory or daily activities.

Complications

Inflammation can affect brain tissue, nerves and CSF flow. Complications may develop during the infection or become apparent later.

Possible complications include:

Not everyone develops lasting problems. Risk depends on age and general health, the bacterium and its antibiotic resistance, the infection source, and how quickly effective treatment begins.

Hearing, thinking or developmental changes may not be obvious immediately, so follow-up testing is important.

- Seizures
- Hearing loss

- Weakness, balance problems or movement difficulties
- Problems with memory, concentration, speech or learning
- Hydrocephalus, a harmful buildup of fluid in the brain
- Ventriculitis, an infection of the brain's fluid-filled spaces
- Stroke caused by inflamed or blocked blood vessels
- Brain abscess
- Bloodstream infection, low blood pressure or organ injury
- Death

Prevention

There is no single vaccine against all Gram-negative meningitis. Vaccines for other causes of bacterial meningitis do not protect against most Gram-negative bacteria.

Some cases cannot be prevented. In healthcare settings, prevention includes hand hygiene, sterile surgical technique, careful device care and removing drains or lines when they are no longer needed.

People with a CSF shunt or drain should follow their surgical team's care instructions. New redness, swelling, tenderness, leaking fluid or device problems need prompt assessment.

Measures to reduce infection during pregnancy, birth and newborn care may prevent some infections in babies. However, parents should not assume a newborn's infection resulted from something they did or failed to do.

Routine household contact does not usually require preventive antibiotics. Public health advice may differ if testing identifies another bacterium that spreads between people.

Living with it and what to expect

Initial treatment usually requires hospitalization and close monitoring. Some people improve steadily after effective antibiotics begin. Others need intensive care, surgery or a longer stay, especially when an infected device, resistant bacterium or complication is present.

Tiredness, headaches, poor concentration and reduced stamina may continue for weeks or months. Recovery can be uneven, and fatigue may increase after returning to work, school or usual activities.

Follow-up may include hearing tests and assessments of movement, vision, speech, memory or mood. Babies and children may need developmental monitoring because some learning or communication difficulties appear later.

Rehabilitation may include physiotherapy, occupational therapy, speech and language therapy, hearing support or psychological care. Temporary adjustments at school or work may help.

Some people recover fully. Others have hearing loss, seizures, weakness, cognitive changes or an ongoing need for shunt care. Follow-up is important for persistent headaches, fatigue, hearing changes, memory problems or emotional effects. These symptoms do not always mean the infection has returned, but they should be assessed if they persist or worsen.

When to get medical help

Call emergency services or go to an emergency department now if someone has possible meningitis symptoms, especially:

Do not wait for every classic symptom. A rash is not required. If meningitis is suspected, the person should not drive themselves.

After treatment, seek urgent medical advice for a returning fever, worsening headache, repeated vomiting, new confusion, a seizure, or redness or leaking fluid around a surgical wound or shunt.

Routine follow-up is appropriate for stable but persistent fatigue, concentration problems, mild headaches, hearing concerns or difficulty returning to normal activities.

- Fever with a severe headache or stiff neck
- New confusion, extreme sleepiness or difficulty waking
- A seizure
- Sudden weakness, trouble speaking or loss of consciousness
- Repeated vomiting with a worsening headache
- A baby who is difficult to wake, feeds poorly or has a bulging soft spot
- Fever or neurological changes after brain surgery or with a CSF device

Common questions

Is Gram-negative meningitis contagious?

Most cases are not spread through casual or household contact. Bacteria such as E. coli and

Pseudomonas usually reach the meninges through the bloodstream, surgery, injury or a medical device. Close contacts do not usually need preventive antibiotics unless testing identifies a contagious cause.

Can Gram-negative meningitis be cured?

Antibiotics can clear the infection, especially when effective treatment begins quickly. However, they cannot always reverse injury that occurred during the illness. Follow-up helps identify and manage lasting effects.

Why is it called Gram-negative?

The name comes from Gram staining, a laboratory test. Gram-negative bacteria have a particular outer structure and appear pink or red after staining. This structure can affect which antibiotics work.

How long does recovery take?

There is no single timetable. Treatment may be prolonged when an infected device, resistant bacterium or complication is present. Fatigue and concentration problems can continue for weeks or months, while neurological injuries may require longer rehabilitation.

Can it come back?

Recurrence is possible but not inevitable. Risk is higher if infected hardware remains, there is an ongoing CSF leak, or the original source has not been controlled. A new fever, severe headache, confusion or shunt problem needs urgent assessment.

Will I need hearing or brain tests afterward?

Follow-up commonly checks for hearing, movement, memory, speech and developmental changes. The tests needed depend on age, symptoms, illness severity and complications.

Sources

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