

Encephalitis

The brain swells from infection or from the body attacking itself by mistake.

Doctors give acyclovir (an antiviral medicine) right away to stop the deadliest virus while tests figure out the exact cause.

THE ONE-LINE TRUTH

A virus sneaks into brain tissue—or the body's defense system mistakenly attacks the brain—and both cause the brain to swell inside the hard skull.

The chain — how it unfolds

1. A virus—usually herpes simplex type 1 (HSV-1)—reactivates from a nerve cluster near the face, or a new virus enters the bloodstream and crosses the blood-brain barrier into brain tissue. — why: HSV-1 lives dormant in the trigeminal ganglion (a cluster of nerve cells near your cheekbone) after a childhood cold sore. Stress, illness, or a weakened immune system lets the virus wake up, travel along nerve fibers, and invade the temporal lobes (the parts of the brain near your ears that handle memory and emotion). Other viruses—like West Nile virus from a mosquito bite, enteroviruses from contaminated water, or varicella-zoster from reactivated chickenpox—reach the brain through the bloodstream by slipping past or breaking through the blood-brain barrier.
2. The virus (or autoimmune antibodies) attacks neurons, especially in the temporal lobes, causing those brain cells to swell and die. — why: HSV-1 loves temporal lobe neurons—those cells control recent memory, emotion, and language. When the virus copies itself inside those neurons, it kills them directly. Dead and dying neurons leak their contents, triggering inflammation. Autoimmune antibodies (like anti-NMDA receptor antibodies) stick to receptors on neurons across the whole brain, blocking normal signals and causing widespread confusion, hallucinations, and abnormal movements.
3. The immune system floods the area with white blood cells, antibodies, and inflammatory chemicals (cytokines), adding even more swelling inside the rigid skull. — why: Immune cells are trying to kill the virus or calm the mistaken attack, but their arrival and the chemicals they release (like interleukin-6 and tumor tissue death (necrosis) factor) make blood vessels leaky. Fluid leaks into brain tissue, the tissue swells, and because the skull is bone and cannot expand, pressure inside the skull (intracranial pressure) rises.

4. Swollen, irritated neurons misfire, sending chaotic electrical signals—this is a seizure. You see shaking, jerking, staring spells, or loss of consciousness. — why: Healthy neurons fire electrical signals in organized, rhythmic patterns. Damaged, swollen neurons fire all at once in a chaotic storm—this misfiring spreads across the brain and causes a seizure. Seizures drain the brain's glucose (sugar) and oxygen, damaging more cells and making confusion worse.
5. Rising pressure inside the skull squeezes blood vessels, cutting oxygen delivery to brain tissue. If untreated, brain tissue starts to die (infarct) or herniate (shift out of place). — why: The skull is a closed box—any swelling inside has nowhere to go, so it squeezes the soft brain against the hard bone. High intracranial pressure flattens blood vessels like stepping on a garden hose, stopping blood flow and starving neurons of oxygen. If pressure keeps rising, brain tissue gets pushed downward through the foramen magnum (the opening at the skull base), crushing the brainstem (which controls breathing and heart rate)—this is called herniation, and it causes coma and death within hours.
6. You see fever (often 102–104°F / 39–40°C), severe headache (from stretched brain coverings called meninges), confusion or bizarre behavior (from damaged temporal and frontal lobes), weakness on one side (if one brain hemisphere is more affected), and seizures. — why: Each symptom maps directly to inflamed or dying brain tissue. Fever comes from the immune fight. Headache comes from swollen meninges (the coverings around the brain) and rising pressure. Confusion, memory loss, and bizarre behavior (saying strange things, acting paranoid, forgetting loved ones) come from damaged temporal lobes. Weakness or paralysis on one side comes from damaged motor areas in the opposite brain hemisphere. Seizures come from misfiring neurons.
7. Without immediate antiviral treatment (acyclovir for HSV) or immune therapy (corticosteroids, intravenous immunoglobulin, or plasmapheresis for autoimmune encephalitis), brain damage becomes permanent—or the person dies. — why: Acyclovir stops HSV-1 from copying its DNA, halting further neuron destruction. Immune therapies (steroids like methylprednisolone, IVIG, or plasmapheresis to filter out antibodies) calm the body's attack on its own brain. Started within the first 48–72 hours, these treatments stop the domino chain and let surviving neurons recover. Delayed treatment leaves dead brain tissue that cannot regenerate—causing permanent memory loss, language problems, personality changes, paralysis, or death. Current guidelines (IDSA, AAN) say to start acyclovir empirically (before test results come back) in anyone with suspected encephalitis because HSV encephalitis is the most treatable cause and delays are deadly.

8. Even with treatment, some people are left with lasting memory trouble, personality changes, movement problems, or seizures that need lifelong medicine. — why: Neurons that died during the infection do not grow back. The temporal lobes (which handle memory, emotion, and language) are often hardest hit by HSV-1, so survivors may forget recent events, struggle to learn new things, lose emotional control, or speak in a flat, slow way. Scar tissue (gliosis) forms in place of dead neurons and can keep triggering abnormal electrical signals—causing epilepsy (repeated seizures) that requires daily antiseizure medicine (like levetiracetam or lamotrigine) for years or life.

Spot it — what you see, and why

- **Fever:** The body raises its temperature to fight the virus or germ attacking the brain. Immune cells release chemicals called cytokines (messengers that sound the alarm) that tell the hypothalamus (the brain's thermostat, deep in the center of your brain) to turn up the heat.
- **Headache:** The meninges (the three thin layers wrapping the brain and spinal cord) and blood vessels swell because of inflammation. Swelling presses on pain-sensing nerves around the brain, triggering a deep, throbbing ache.
- **Confusion or change in behavior:** The infection damages neurons (brain cells that send messages) in the cerebral cortex (the outer layer that controls thinking, memory, and personality). When those cells stop working right, the person can't think clearly or act like themselves.
- **Seizures:** Inflamed brain tissue becomes irritable and sends out chaotic electrical signals, like short circuits. These wild bursts of activity spread through the cortex and cause muscles to shake or jerk, or the person to lose awareness and stare.
- **Weakness or trouble moving one side of the body:** Swelling or cell damage hits the motor cortex (the strip of brain near the top that sends 'move' signals to muscles) or the corticospinal tract (the highway carrying those signals down to the spinal cord). When those pathways break, muscles on one side of the body can't get the command.
- **Trouble speaking or understanding words:** Inflammation in language centers like Broca's area (front left brain, for forming words) or Wernicke's area (back left brain, for understanding words) disrupts the circuits that turn thoughts into speech or decode the meaning of sounds.

Red flags — act now

- Seizures or repeated jerking movements
- Cannot stay awake or is very hard to wake up
- Sudden weakness or numbness on one side of the body

- Severe confusion or aggressive, strange behavior that is brand new
- Trouble breathing or very slow, irregular breathing

Treat it — in this order

1. IV acyclovir 10 mg/kg every 8 hours (or 30 mg/kg/day divided into three doses), started immediately even before test results return → Acyclovir blocks the enzyme HSV needs to copy its genetic material (DNA polymerase), stopping the virus from spreading to more brain cells. Starting it within hours of suspecting encephalitis cuts the risk of death or permanent brain damage in half. Every hour of delay allows more neurons to die—HSV encephalitis has over 70% mortality without treatment, but under 20% with early acyclovir.
2. Anti-seizure medication—lorazepam 0.1 mg/kg IV (up to 4 mg per dose) for active seizures; levetiracetam 1000–1500 mg IV load (then 500–1000 mg every 12 hours) or fosphenytoin 15–20 mg phenytoin equivalents (PE) per kg IV load for seizure prevention → Lorazepam boosts GABA (the brain's main calming messenger), stopping the chaotic electrical storm of a seizure within minutes. Levetiracetam or fosphenytoin keeps the brain's electrical threshold high, preventing new seizures while the inflammation is treated. Stopping seizures protects neurons from exhaustion, oxygen starvation, and death.
3. IV methylprednisolone 1 gram daily for 3–5 days or IV immunoglobulin (IVIG) 2 g/kg total dose divided over 2–5 days, if autoimmune encephalitis is suspected or confirmed → Steroids shut down the immune system's attack on brain tissue by blocking inflammatory signals (cytokines like interleukin-1 and TNF-alpha). IVIG floods the bloodstream with normal antibodies that distract and neutralize the harmful autoantibodies attacking the brain. Both reduce brain swelling from the inside and stop further damage when the cause is autoimmune, not infectious.
4. Mannitol 0.25–1 g/kg IV bolus over 15–30 minutes or hypertonic saline (3% NaCl) 250 mL IV bolus to reduce intracranial pressure if signs of brain herniation appear (blown pupil, posturing, sudden decreased consciousness) → These solutions pull water out of swollen brain tissue and into the blood vessels through osmosis (water moving toward higher salt concentration), lowering the pressure inside the skull. This buys time by preventing the brain from being squeezed down through the base of the skull (herniation), which cuts off blood flow to the brainstem and causes death within minutes to hours.

5. Supportive care in the ICU—mechanical ventilation if needed to protect the airway, fever control with acetaminophen 15 mg/kg every 4–6 hours (max 4 grams per day in adults) or cooling blanket, head of bed elevated 30 degrees, and hourly neurologic checks → Lowering fever reduces the brain's oxygen and energy demand when it is already struggling. Elevating the head helps blood and cerebrospinal fluid drain away from the brain through the jugular veins, reducing pressure. Mechanical ventilation ensures oxygen reaches the brain even if the person cannot breathe well on their own or is too drowsy to protect their airway from choking. Close monitoring catches any sudden worsening (like new seizures, blown pupil, or signs of herniation) within minutes, not hours.

Your top priorities at the bedside

1. Check airway, breathing, and oxygen saturation every 15 minutes until stable; keep oxygen saturation above 94 percent with supplemental oxygen — why: Encephalitis can damage the brainstem (the part that controls automatic breathing), and swelling inside the hard skull pushes brain tissue downward into the breathing-control centers, causing slow or stopped breathing
2. Perform and document a full neurological check every hour: Glasgow Coma Scale score, pupil size and reaction to light, arm and leg strength on both sides, and ability to follow commands — why: The brain swells quickly inside the rigid skull, and rising intracranial pressure (pressure inside the skull) will show up first as drowsiness, unequal pupils, or new weakness; catching these changes early lets the team give medicines or surgery to save brain tissue
3. Start IV acyclovir within 30 minutes of the order and give every 8 hours on time; hang each dose over 1 hour and flush the line with at least 100 mL normal saline after each infusion — why: Herpes simplex virus kills brain cells every hour treatment is delayed; acyclovir stops the virus from copying itself, but it crystallizes in the kidney tubules and causes kidney failure if we push it too fast or do not flush with extra fluid