[Template:Infobox drug](/wiki/Template:Infobox_drug" \o "Template:Infobox drug)

**Gabapentin**, marketed under the brand name **Neurontin** among others, is a medication used to treat [epilepsy](/wiki/Epilepsy), [neuropathic pain](/wiki/Neuropathic_pain), [hot flashes](/wiki/Hot_flashes), and [restless leg syndrome](/wiki/Restless_leg_syndrome).<ref name=AHFS2015>[Template:Cite web](/wiki/Template:Cite_web)</ref>[[1]](#cite_note-1) In epilepsy it may be used for those with [partial seizures](/wiki/Partial_seizures).<ref name=AHFS2015/> It is recommended as one of a number of first line medications for the treatment of neuropathic pain in [diabetic neuropathy](/wiki/Diabetic_neuropathy), [post-herpetic neuralgia](/wiki/Post-herpetic_neuralgia), and [central neuropathic pain](/wiki/Central_neuropathic_pain).<ref name=Attal2010>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> For neuropathic pain about 14% of people have a meaningful benefit.<ref name=Moore2014>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

Common side effects include sleepiness and [dizziness](/wiki/Dizziness). Serious side effects may include an increased risk of [suicide](/wiki/Suicide), aggressive behaviour, and [drug reaction with eosinophilia and systemic symptoms](/wiki/Drug_reaction_with_eosinophilia_and_systemic_symptoms).<ref name=AHFS2015/> It is unclear if it is safe during [pregnancy](/wiki/Pregnancy) or [breastfeeding](/wiki/Breastfeeding).[[2]](#cite_note-2) Lower doses should be used in people with [kidney problems](/wiki/Kidney_problems). Gabapentin does not affect the activity of the inhibitory neurotransmitter [γ-aminobutyric acid](/wiki/Γ-aminobutyric_acid) (GABA); how it works is unclear.<ref name=AHFS2015/>

Gabapentin was first approved for use in 1993.[[3]](#cite_note-3) The wholesale price is about 1.35 USD per day.[[4]](#cite_note-4) In the United States it has been available as a [generic medication](/wiki/Generic_medication) since 2004.<ref name=AHFS2015/> As of 2015 the cost for a typical month of medication in the United States is 100 to 200 USD.<ref name=Ric2015>[Template:Cite book](/wiki/Template:Cite_book)</ref> During the 1990s [Parke-Davis](/wiki/Parke-Davis), a sub-company of [Pfizer](/wiki/Pfizer), used a number of techniques to encourage physicians in the United States to use gabapentin for [unapproved uses](/wiki/Off-label_use).[[5]](#cite_note-5)[Template:TOC limit](/wiki/Template:TOC_limit)

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## Medical uses[[edit](/index.php?title=(none)&action=edit&section=1)]

Gabapentin is used primarily to treat [seizures](/wiki/Seizure) and [neuropathic pain](/wiki/Neuropathic_pain).<ref name=AHFS>[Template:Cite web](/wiki/Template:Cite_web)</ref> It is also commonly prescribed for many [off-label uses](/wiki/Off-label_use), such as treatment of [anxiety disorders](/wiki/Anxiety_disorder),[[6]](#cite_note-6)[[7]](#cite_note-7) [insomnia](/wiki/Insomnia), and [bipolar disorder](/wiki/Bipolar_disorder).[[6]](#cite_note-6) There are, however, concerns regarding the quality of the trials conducted and evidence for some such uses, especially in the case of its use as a [mood stabilizer](/wiki/Mood_stabilizer) in bipolar disorder.[[8]](#cite_note-8)

### Seizures[[edit](/index.php?title=(none)&action=edit&section=2)]

Gabapentin is approved for treatment of [focal seizures](/wiki/Focal_seizures),[[9]](#cite_note-9) [partial seizures](/wiki/Partial_seizures) and [mixed seizures](/wiki/Mixed_seizures). There is insufficient evidence for its use in [generalized epilepsy](/wiki/Generalized_epilepsy).[[10]](#cite_note-10)

### Pain[[edit](/index.php?title=(none)&action=edit&section=3)]

There is weak evidence that gabapentin provides meaningful pain relief for around 14% of people who take it for [fibromyalgia](/wiki/Fibromyalgia) and chronic neuropathic pain.<ref name=Moore2014/> Evidence is very little for neuropathic pain from conditions other than [postherpetic neuralgia](/wiki/Postherpetic_neuralgia), [diabetic neuropathy](/wiki/Diabetic_neuropathy), and fibromyalgia.<ref name=Moore2014/> It may be helpful in neuropathic pain due to [cancer](/wiki/Cancer).[[11]](#cite_note-11) It is not effective in HIV-associated sensory neuropathy.[[12]](#cite_note-12) When used for neuropathic pain it does not appear superior to [carbamazepine](/wiki/Carbamazepine).[[13]](#cite_note-13) It appears to be as effective as [pregabalin](/wiki/Pregabalin) and costs less.[[14]](#cite_note-14) It does not appear to provide benefit for [complex regional pain syndrome](/wiki/Complex_regional_pain_syndrome)[[15]](#cite_note-15) Gabapentin may reduce [opioid](/wiki/Opioid) use following surgery, but does not help with chronic pain after surgery.[[16]](#cite_note-16) There is no evidence that it is useful for [migraine](/wiki/Migraine) prevention.[[17]](#cite_note-17)

### Anxiety disorders[[edit](/index.php?title=(none)&action=edit&section=4)]

Gabapentin is effective in [social anxiety disorder](/wiki/Social_anxiety_disorder), [panic disorder](/wiki/Panic_disorder),[[18]](#cite_note-18)[[19]](#cite_note-19) and generalized anxiety disorder.[[6]](#cite_note-6)[[7]](#cite_note-7)

### Other uses[[edit](/index.php?title=(none)&action=edit&section=5)]

Gabapentin may be useful in the treatment of comorbid anxiety in bipolar patients, (however not the bipolar state itself).[[8]](#cite_note-8)[[20]](#cite_note-20)[[21]](#cite_note-21)Gabapentin may be effective in [acquired pendular nystagmus](/wiki/Acquired_pendular_nystagmus) and [infantile nystagmus](/wiki/Infantile_nystagmus), (but not [periodic alternating nystagmus](/wiki/Periodic_alternating_nystagmus)).[[22]](#cite_note-22)[[23]](#cite_note-23) It is effective in [hot flashes](/wiki/Hot_flash).[[24]](#cite_note-24)[[25]](#cite_note-25)[[26]](#cite_note-26) It may be effective in reducing pain and spasticity in [multiple sclerosis](/wiki/Multiple_sclerosis).<ref name = evid>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Gabapentin may reduce symptoms of [alcohol withdrawal](/wiki/Alcohol_withdrawal) (but it does not prevent the associated seizures).[[27]](#cite_note-27) Use for [smoking cessation](/wiki/Smoking_cessation) has had mixed results.[[28]](#cite_note-28)[[29]](#cite_note-29) Gabapentin is effective in alleviating itching in renal failure ([uremic pruritus](/wiki/Uremic_pruritus))[[30]](#cite_note-30) and itching of other causes.[[31]](#cite_note-31) It is an established treatment of [restless leg syndrome](/wiki/Restless_leg_syndrome).[[32]](#cite_note-32) Gabapentin may help sleeping problems in people with restless leg syndrome and partial seizures.[[33]](#cite_note-33)[[34]](#cite_note-34) Gabapentin may be an option in [essential](/wiki/Essential_tremor) or [orthostatic tremor](/wiki/Orthostatic_tremor).[[35]](#cite_note-35)[[36]](#cite_note-36)[[37]](#cite_note-37) Gabapentin is not effective alone as a mood-stabilizing treatment for bipolar disorder.[[6]](#cite_note-6) There is insufficient evidence to support its use in [obsessive-compulsive disorder](/wiki/Obsessive-compulsive_disorder) and [treatment-resistant depression](/wiki/Treatment-resistant_depression). Gabapentin does not appear effective for the treatment of [tinnitus](/wiki/Tinnitus).[[38]](#cite_note-38)

## Adverse effects[[edit](/index.php?title=(none)&action=edit&section=6)]

The most common [side effects](/wiki/Side_effect) of gabapentin include [dizziness](/wiki/Dizziness), [fatigue](/wiki/Fatigue_(medical)), [drowsiness](/wiki/Drowsiness), [ataxia](/wiki/Ataxia), [peripheral edema](/wiki/Peripheral_edema) (swelling of extremities), [nystagmus](/wiki/Nystagmus), and [tremor](/wiki/Tremor).[[39]](#cite_note-39) Gabapentin may also produce [sexual dysfunction](/wiki/Sexual_dysfunction) in some patients, symptoms of which may include loss of [libido](/wiki/Libido), inability to reach [orgasm](/wiki/Orgasm), and [erectile dysfunction](/wiki/Erectile_dysfunction).[[40]](#cite_note-40)[[41]](#cite_note-41) Gabapentin should be used carefully in patients with [renal impairment](/wiki/Renal_failure) due to possible accumulation and toxicity.[[42]](#cite_note-42) An increase in formation of [adenocarcinomas](/wiki/Adenocarcinoma) was observed in rats during preclinical trials; however, the clinical significance of these results remains undetermined. Gabapentin is also known to induce [pancreatic acinar cell carcinomas](/wiki/Pancreatic_acinar_cell_carcinoma) in rats through an unknown mechanism, perhaps by stimulation of DNA synthesis; these tumors did not affect the lifespan of the rats and did not [metastasize](/wiki/Metastasize).[[43]](#cite_note-43)

### Suicide[[edit](/index.php?title=(none)&action=edit&section=7)]

In 2009 the [U.S. Food and Drug Administration](/wiki/Food_and_Drug_Administration) issued a warning of an increased risk of depression and suicidal thoughts and behaviors in patients taking gabapentin, along with other anticonvulsant drugs[[44]](#cite_note-44) modifying the [packaging insert](/wiki/Black_box_warning) to reflect this.[[39]](#cite_note-39) A 2010 meta analysis confirmed the increased risk of suicide associated with gabapentin use.[[45]](#cite_note-45)

### Overdose[[edit](/index.php?title=(none)&action=edit&section=8)]

Persons who accidentally or intentionally ingested overdoses may have drowsiness, sedation, blurred vision, slurred speech, somnolence and possibly death, if a very high amount was taken, particularly if combined with alcohol. Serum gabapentin concentrations may be measured to confirm diagnosis.[[46]](#cite_note-46)

## Pharmacology[[edit](/index.php?title=(none)&action=edit&section=9)]

Gabapentin was initially synthesized to mimic the [chemical structure](/wiki/Chemical_structure) of the [neurotransmitter](/wiki/Neurotransmitter) gamma-aminobutyric acid ([GABA](/wiki/GABA)), but is believed to act on different brain receptors.[Template:Citation needed](/wiki/Template:Citation_needed)

Some of its activity may involve interaction with [voltage-gated calcium channels](/wiki/Voltage-gated_calcium_channels). Gabapentin binds to the α2δ subunit ([1](/wiki/CACNA2D1) and [2](/wiki/CACNA2D2)) and has been found to reduce calcium currents after chronic but not acute application via an effect on trafficking[[47]](#cite_note-47) of voltage-dependent calcium channels in the [central nervous system](/wiki/Central_nervous_system).[[48]](#cite_note-48) Another possible mechanism of action is that gabapentin halts the formation of new synapses.[[49]](#cite_note-49)

## Mechanism of action[[edit](/index.php?title=(none)&action=edit&section=10)]

The mechanism of the anticonvulsant action of gabapentin has not been fully described. Several possible mechanisms for pain improvement have been discussed.[[50]](#cite_note-50) Though similar in structure to the endogenous neurotransmitter [GABA](/wiki/GABA), gabapentin has not been shown to bind to GABA receptors at concentrations at or below 1 mM.[[51]](#cite_note-51) Gabapentin modulates the action of [glutamate decarboxylase](/wiki/Glutamate_decarboxylase) (GAD) and [branched chain aminotransferase](/wiki/Branched_chain_aminotransferase) (BCAT), two enzymes involved in GABA [biosynthesis](/wiki/Biosynthesis). In human and rat studies, gabapentin was found to increase GABA biosynthesis, and to increase non-synaptic GABA neurotransmission [*in vitro*](/wiki/In_vitro).[[52]](#cite_note-52) Gabapentin has been shown to bind to the α2δ-1 subunit of voltage gated calcium [ion channels](/wiki/Ion_channels), which contributes to its pain attenuation effects in diabetic neuropathy and post-herpetic neuralgia. Other neurophysiological findings indicate that gabapentin also interacts with [NMDA receptors](/wiki/NMDA_receptors), [protein kinase C](/wiki/Protein_kinase_C), and inflammatory [cytokines](/wiki/Cytokines).[[51]](#cite_note-51)[[53]](#cite_note-53)

## Society and culture[[edit](/index.php?title=(none)&action=edit&section=11)]

### Sales[[edit](/index.php?title=(none)&action=edit&section=12)]

Gabapentin is best known under the brand name Neurontin manufactured by [Pfizer](/wiki/Pfizer) subsidiary [Parke-Davis](/wiki/Parke-Davis). A Pfizer subsidiary named Greenstone markets generic gabapentin.

In December 2004 the FDA granted final approval to a generic equivalent to Neurontin made by the Israeli firm [Teva](/wiki/Teva_Pharmaceutical_Industries).

Neurontin began as one of Pfizer's best selling drugs; however, Pfizer was criticized and under litigation for its marketing of the drug. They faced allegations that Parke-Davis marketed the drug for at least a dozen supposed uses that the [FDA](/wiki/David_Franklin_(scientist)) had not approved.[[5]](#cite_note-5)[[54]](#cite_note-54) It has been used as a mainstay drug for migraines, even though it was not approved for such use in 2004.[[55]](#cite_note-55)

### FDA approval[[edit](/index.php?title=(none)&action=edit&section=13)]

Gabapentin was originally approved by the [U.S. Food and Drug Administration](/wiki/Food_and_Drug_Administration) (FDA) in December 1993, for use as an adjuvant (effective when added to other antiseizure drugs) medication to control [partial seizures](/wiki/Focal_seizure) in adults; that indication was extended to children in 2000.<ref name=Mack>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> In 2004, its use for treating [postherpetic neuralgia](/wiki/Postherpetic_neuralgia) (neuropathic pain following [shingles](/wiki/Shingles)) was approved.<ref name=Mack/>[[56]](#cite_note-56)

### Off-label promotion[[edit](/index.php?title=(none)&action=edit&section=14)]

Although some small, non-controlled studies in the 1990s—mostly sponsored by gabapentin's manufacturer—suggested that treatment for bipolar disorder with gabapentin may be promising,[[57]](#cite_note-57) the preponderance of evidence suggests that it is not effective.[[58]](#cite_note-58) Subsequent to the corporate acquisition of the original patent holder, the pharmaceutical company [Pfizer](/wiki/Pfizer) admitted that there had been violations of FDA guidelines regarding the promotion of unproven off-label uses for gabapentin in the [Franklin v. Pfizer](/wiki/Gabapentin#Franklin_v._Pfizer_case) case.

[Reuters](/wiki/Reuters) reported on March 25, 2010, that "Pfizer Inc violated federal racketeering law by improperly promoting the epilepsy drug Neurontin ... Under federal RICO law the penalty is automatically tripled, so the finding will cost Pfizer $141 million."[[59]](#cite_note-59) The case stems from a claim from Kaiser Foundation Health Plan Inc. that "it was misled into believing Neurontin was effective for off-label treatment of migraines, bipolar disorder and other conditions. Pfizer argued that Kaiser physicians still recommend the drug for those uses."[[60]](#cite_note-60) [*Bloomberg News*](/wiki/Bloomberg_News) reported "during the trial, Pfizer argued that Kaiser doctors continued to prescribe the drug even after the health insurer sued Pfizer in 2005. The insurer's website also still lists Neurontin as a drug for neuropathic pain, Pfizer lawyers said in closing argument."[[61]](#cite_note-61) [*The Wall Street Journal*](/wiki/The_Wall_Street_Journal) noted that Pfizer spokesman Christopher Loder said, "We are disappointed with the verdict and will pursue post-trial motions and an appeal."[[62]](#cite_note-62) He would later add that "the verdict and the judge's rulings are not consistent with the facts and the law."[[59]](#cite_note-59)

#### ''Franklin v. Pfizer'' case[[edit](/index.php?title=(none)&action=edit&section=15)]

[Template:Main](/wiki/Template:Main) According to the *San Francisco Chronicle*, [*off-label*](/wiki/Off-label_use) prescriptions accounted for roughly 90 percent of Neurontin sales.[[63]](#cite_note-63) While off-label prescriptions are common for a number of drugs and are legal, marketing of off-label uses of a drug is not.[[5]](#cite_note-5) In 2004, [Warner-Lambert](/wiki/Warner-Lambert) (which subsequently was acquired by Pfizer) agreed to plead guilty for activities of its Parke-Davis subsidiary, and to pay $430 million in fines to settle civil and criminal charges regarding the marketing of Neurontin for off-label purposes. The 2004 settlement was [one of the largest](/wiki/List_of_Largest_Pharmaceutical_Settlements) in U.S. history, and the [first off-label promotion case](/wiki/List_of_off-label_promotion_pharmaceutical_settlements) brought successfully under the False Claims Act.

### Brand names[[edit](/index.php?title=(none)&action=edit&section=16)]

Gabapentin was originally marketed under the brand name Neurontin and since it became generic, it has been marketed under many other brand names.<ref name=drugs.com/>

[thumb|A capsule of gabapentin](/wiki/File:Gabapentin_capsule.jpg)

### Related drugs[[edit](/index.php?title=(none)&action=edit&section=17)]

[Parke-Davis](/wiki/Parke-Davis) developed a drug called [pregabalin](/wiki/Pregabalin) as a successor to gabapentin.[[64]](#cite_note-64) Pregabalin was brought to market by Pfizer as [Lyrica](/wiki/Lyrica) after the company acquired Warner-Lambert. Pregabalin is related in structure to gabapentin.[[65]](#cite_note-65) Another new drug [atagabalin](/wiki/Atagabalin) has been trialed by Pfizer as a treatment for [insomnia](/wiki/Insomnia).[[66]](#cite_note-66) A [prodrug](/wiki/Prodrug) form ([gabapentin enacarbil](/wiki/Gabapentin_enacarbil))[[67]](#cite_note-67) was approved in 2011 for the treatment of moderate-to-severe restless legs syndrome[[68]](#cite_note-68) and in 2012 for [postherpetic neuralgia](/wiki/Postherpetic_neuralgia) in adults.[[69]](#cite_note-69) It was designed for increased oral [bioavailability](/wiki/Bioavailability) over gabapentin.[[70]](#cite_note-70)[[71]](#cite_note-71)

## Veterinary use[[edit](/index.php?title=(none)&action=edit&section=18)]

Gabapentin is also used for some animal treatments, but some formulations (especially liquid forms) for human use contains the sweetener [xylitol](/wiki/Xylitol), which is toxic to dogs.[[72]](#cite_note-72)

## References[[edit](/index.php?title=(none)&action=edit&section=19)]

[Template:Reflist](/wiki/Template:Reflist)

## External links[[edit](/index.php?title=(none)&action=edit&section=20)]

* [DrugBank: gabapentin](http://www.drugbank.ca/drugs/DB00996)
* [Gabapentin information from MedlinePlus](http://www.nlm.nih.gov/medlineplus/druginfo/meds/a694007.html)
* ["Gabapentin"](http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0000940/) PubMed Health. National Center for Biotechnology Information (NCBI)
* ["Suicidal Behavior and Ideation and Antiepileptic Drugs"](http://www.fda.gov/Drugs/DrugSafety/PostmarketDrugSafetyInformationforPatientsandProviders/ucm100190.htm) [U.S. Food and Drug Administration](/wiki/Food_and_Drug_Administration) (FDA)
* [Neurontin](http://topics.nytimes.com/topics/news/health/diseasesconditionsandhealthtopics/neurontin_drug/) collected news and commentary at [*The New York Times*](/wiki/The_New_York_Times)
* ["Gabapentin"](http://druginfo.nlm.nih.gov/drugportal/dpdirect.jsp?name=Gabapentin) Drug Information Portal. U.S. National Library of Medicine.

[Template:Anticonvulsants](/wiki/Template:Anticonvulsants) [Template:Neuropathic pain and fibromyalgia pharmacotherapies](/wiki/Template:Neuropathic_pain_and_fibromyalgia_pharmacotherapies) [Template:Anxiolytics](/wiki/Template:Anxiolytics) [Template:Channel blockers](/wiki/Template:Channel_blockers)

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