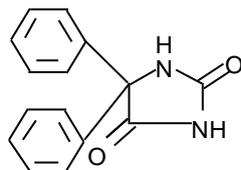


# PRODUCT INFORMATION

## DILANTIN® (phenytoin)

### NAME OF THE MEDICINE

Dilantin contains the active component phenytoin. The molecular structure of phenytoin is shown below:



Chemical name:	5,5-diphenylimidazolidine-2,4-dione
Molecular formula:	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>
Molecular weight:	252.272
CAS registry number:	57-41-0.

### DESCRIPTION

Phenytoin is a white, or almost white, odourless or almost odourless, crystalline powder. It is practically insoluble in water and soluble 1 in 70 alcohol.

Phenytoin sodium is the sodium salt of phenytoin. It is a white, odourless, slightly hygroscopic crystalline powder. It is soluble in water and alcohol.

Dilantin Capsules contain phenytoin sodium 30 mg and 100 mg. The 30 mg capsules also contain lactose monohydrate, Confectioner's sugar (PI: 1749) (sucrose with 3% maize starch), magnesium stearate, purified talc, titanium dioxide, carbon black and gelatin. The 100 mg capsules also contain lactose monohydrate, Confectioner's sugar (PI: 1749) (sucrose with 3% maize starch), purified talc, magnesium stearate, titanium dioxide, sunset yellow FCF, erythrosine, carbon black and gelatin.

Dilantin Capsules in vivo performance is characterized by a slow and extended rate of absorption with peak blood concentrations expected in 4 to 12 hours.

Dilantin Infatabs contain phenytoin 50 mg with sucrose, sunset yellow FCF, maize starch, quinoline yellow, saccharin sodium, magnesium stearate, purified talc and spearmint flavour.

Dilantin Paediatric Suspension contains phenytoin 30 mg/5 mL. Dilantin Paediatric Suspension also contains sodium benzoate, sucrose, glycerol, aluminium magnesium silicate, carmellose sodium, polysorbate 40, vanillin, orange flavour, ethanol, carmoisine, sunset yellow FCF, citric acid monohydrate, hydrochloric acid, banana flavour and purified water.

## PHARMACOLOGY

### Pharmacological Action

Dilantin is an anticonvulsant drug, which can be useful in the treatment of epilepsy. The primary site of action appears to be the motor cortex, where the spreading of seizure activity is inhibited. It is likely that by promoting sodium efflux from neurones, Dilantin tends to stabilise the threshold against hyperexcitability caused by excessive stimulation or those environmental changes capable of reducing the gradient of sodium ions through membranes. This also applies to the reduction of post-tetanic potentiation at synapse level. Losing post-tetanic potential prevents the cortical seizure foci from deteriorating neighbouring cortical areas. In this sense, Dilantin reduces the maximal activity of brain centres associated with the tonic phase of grand mal seizures.

### Pharmacokinetics

In general the reported plasma half-life of phenytoin averages 22 hours, with a range of 7 to 42 hours. Steady-state therapeutic levels are achieved at least 7 to 10 days (5 to 7 half-lives) after initiation of therapy with recommended doses of 300 mg/day.

For Dilantin Capsules, peak serum levels occur 4 to 12 hours after administration.

Conventionally, with drugs following linear kinetics the half-life is used to determine the dose rate, drug accumulation and the time to reach steady-state. Phenytoin, however, demonstrates non-linear kinetics and therefore the half-life is affected by the degree of absorption, saturation of metabolic pathways, dose and the degree of metabolic enzyme induction. This results in considerable inter- and intra-patient variability in phenytoin pharmacokinetics. As a consequence the clinical relevance of reported phenytoin half-life values are limited and cannot be used in the conventional manner to estimate the dosage regimen. When administering phenytoin to a patient it is necessary to measure serum levels as this provides the most accurate means of deriving a suitable dosage regimen.

Serum level determinations should originally be obtained at least 7 to 10 days after treatment initiation, dosage change, or addition or subtraction of another drug to the regimen so that equilibrium or steady-state will have been achieved. Further serum level determinations may be required to further refine the dosage regimen. Trough levels provide information about clinically effective serum level range and confirm patient compliance and are obtained just prior to the patient's next scheduled dose. Peak levels indicate an individual's threshold for emergence of dose-related side effects and are obtained at the time of expected peak concentration.

Optimum control without clinical signs of toxicity occurs more often with serum levels between 10 µg/mL and 20 µg/mL. Therapeutic concentrations of free (unbound) phenytoin, which are frequently monitored in patients with altered protein-binding, usually fall in the range of 0.8 µg/mL to 2 µg/mL.

In most patients maintained at steady dosage, stable phenytoin serum levels are achieved. There may be wide interpatient variability in phenytoin serum levels with equivalent dosages. Patients with unusually low levels may be noncompliant or hypermetabolisers of phenytoin.

Unusually high levels of phenytoin result from liver disease, congenital enzyme deficiency or drug interactions, which result in metabolic interference. Patients with large variations in phenytoin plasma levels, despite standard doses, present a difficult clinical problem. Serum level determinations in such patients may be particularly helpful. Phenytoin is about 90% protein bound. As phenytoin is highly protein bound, free phenytoin levels may be altered in patients whose protein binding characteristics differ from normal. Protein binding may be lower in neonates and hyperbilirubinaemic infants; also altered in patients with hypoalbuminaemia, uraemia or acute trauma and in pregnancy.

Most of the drug is excreted in the bile as inactive metabolites which are then reabsorbed from the intestinal tract and excreted in the urine. Urinary excretion of phenytoin and its metabolites occurs partly with glomerular filtration but more importantly with tubular secretion. Phenytoin is metabolised in the liver primarily by CYP2C9 (major) and CYP2C19 (minor) (see **INTERACTIONS WITH OTHER MEDICINES**). The major inactive metabolite is 5-(p-hydroxyphenyl)-5-phenylhydantoin (HPPH). The rate of metabolism is increased in younger children, pregnant women, in women during menses and in patients with acute trauma. The rate decreased with advancing age. Phenytoin may be metabolised slowly in a small number of individuals due to genetic polymorphism, which may cause isoenzyme mutations (e.g. CYP2C9/19), limited enzyme availability and lack of induction (e.g. CYP3A4). Because phenytoin is hydroxylated in the liver by an enzyme system which is saturable, at high plasma levels small incremental doses may increase the half-life and produce very substantial increases in serum levels, when these are in the upper range.

The steady-state level may be disproportionately increased, with resultant intoxication, from an increase in dosage of 10% or more.

### **Food effect of bioavailability of Dilantin Capsules**

The C<sub>max</sub> and AUC data from a food-effect study involving administration of Dilantin 100 mg to healthy volunteers under fasting conditions and with a high-fat meal indicated that exposure to the drug is not affected by food.

## **INDICATIONS**

Dilantin is indicated for the control of grand mal and psychomotor seizures. Dilantin will prevent or effectively decrease the incidence and severity of convulsive seizures in a high percentage of cases, with patients exhibiting little tendency to become resistant to its action. Besides its effectiveness in controlling seizures, Dilantin frequently improves the mental condition and outlook of epileptic patients and there is also increasing evidence that Dilantin is valuable in the prevention of seizures occurring during or after neurosurgery. Phenytoin serum level determinations may be necessary for optimal dosage adjustments (see **DOSAGE AND ADMINISTRATION**).

## **CONTRAINDICATIONS**

Patients with a history of hypersensitivity to phenytoin, or other hydantoin products, or other inactive ingredients in this product.

Co-administration of phenytoin with delavirdine is contraindicated due to the potential for loss of virologic response and possible resistance to delavirdine or to the class of non-nucleoside reverse transcriptase inhibitors.

## **PRECAUTIONS**

### **General**

Phenytoin is not effective for absence (petit-mal) seizures. If tonic-clonic (grand-mal) and absence (petit-mal) seizures are present, combined drug therapy is needed.

Phenytoin is not indicated for seizures due to hypoglycaemic or other metabolic causes. Appropriate diagnostic procedures should be performed as indicated.

Phenytoin should not be abruptly discontinued because of the possibility of increased seizure frequency, including status epilepticus, hence any need for dosage reduction, discontinuation, or substitution of alternative antiepileptic medication should be implemented gradually. However, in the event of an allergic or hypersensitivity reaction, rapid substitution of an alternative therapy may be necessary. In this case, alternative therapy should be an antiepileptic drug not belonging to the hydantoin chemical class.

In some individuals, the rate of phenytoin metabolism has been shown to be slower than normal. This slow rate of degradation may be due to enzymatic unavailability or to defective induction mechanisms, effects that appear to be genetically determined.

Acute alcoholic intake may increase phenytoin serum levels while chronic alcoholic use may decrease serum levels.

Due to an increased fraction of unbound phenytoin in patients with renal or hepatic disease, or in those with hypoalbuminaemia, the interpretation of total phenytoin plasma concentrations should be made with caution. Unbound concentration of phenytoin may be elevated in patients with hyperbilirubinaemia. Unbound phenytoin concentrations may be more useful in these patient populations.

### **Suicidal Behaviour and Ideation**

Antiepileptic drugs (AEDs), including phenytoin, increase the risk of suicidal thoughts or behaviour in patients taking these drugs for any indication. Patients treated with any AED for any indication should be monitored for the emergence or worsening of depression, suicidal thoughts or behaviour, and/or any unusual changes in mood or behaviour.

Pooled analyses of 199 placebo-controlled clinical trials (mono- and adjunctive therapy) of 11 different AEDs showed that patients randomised to one of the AEDs had approximately twice the risk (adjusted Relative Risk 1.8, 95% CI:1.2, 2.7) of suicidal thinking or behaviour compared to patients randomised to placebo. In these trials, which had a median treatment duration of 12 weeks, the estimated incidence rate of suicidal behaviour or ideation among 27,863 AED-treated patients was 0.43%, compared to 0.24% among 16,029 placebo-treated patients, representing an increase of approximately one case of suicidal thinking or behaviour for every 530 patients treated. There were four suicides in drug-treated patients in the trials

and none in placebo-treated patients, but the number is too small to allow any conclusion about drug effect on suicide.

The increased risk of suicidal thoughts or behaviour with AEDs was observed as early as one week after starting drug treatment with AEDs and persisted for the duration of treatment assessed. Because most trials included in the analysis did not extend beyond 24 weeks, the risk of suicidal thoughts or behaviour beyond 24 weeks could not be assessed.

The risk of suicidal thoughts or behaviour was generally consistent among drugs in the data analysed. The finding of increased risk with AEDs of varying mechanisms of action and across a range of indications suggests that the risk applies to all AEDs used for any indication. The risk did not vary substantially by age (5-100 years) in the clinical trials analysed. Table 1 shows absolute and relative risk by indication for all evaluated AEDs.

**Table 1 Risk by indication for antiepileptic drugs in the pooled analysis**

Indication	Placebo Patients with Events Per 1000 Patients	Drug with Events Per 1000 Patients	Relative Incidence Events in Placebo Patients	Risk: Risk of Additional Drug Events Per 1000 Patients	Risk Difference: Drug with Events Per 1000 Patients
Epilepsy	1.0	3.4	3.5	2.4	
Psychiatric	5.7	8.5	1.5	2.9	
Other	1.0	1.8	1.9	0.9	
Total	2.4	4.3	1.8	1.9	

The relative risk for suicidal thoughts or behaviour was higher in clinical trials for epilepsy than in clinical trials for psychiatric or other conditions, but the absolute risk differences were similar for the epilepsy and psychiatric indications.

Anyone considering prescribing phenytoin or any other AED must balance this risk with the risk of untreated illness. Epilepsy and many other illnesses for which AEDs are prescribed are themselves associated with morbidity and mortality and an increased risk of suicidal thoughts and behaviour. Should suicidal thoughts and behaviour emerge during treatment, the prescriber needs to consider whether the emergence of these symptoms in any given patient may be related to the illness being treated.

Patients, their caregivers, and families should be informed that AEDs increase the risk of suicidal thoughts and behaviour and should be advised of the need to be alert for the emergence or worsening of the signs and symptoms of depression, any unusual changes in mood or behaviour, or the emergence of suicidal thoughts, behaviour, or thoughts about self-harm. Behaviours of concern should be reported immediately to the treating doctor.

## **Hypersensitivity Syndrome/Drug Reaction with Eosinophilia and Systemic Symptoms**

Hypersensitivity syndrome (HSS) or drug reaction with eosinophilia and systemic symptoms (DRESS) has been reported in patients taking anticonvulsant drugs, including phenytoin. Some of these events have been fatal or life threatening.

HSS/DRESS typically, although not exclusively, presents with fever, rash, and/or lymphadenopathy, in association with other organ system involvement, such as hepatitis, nephritis, haematological abnormalities, myocarditis, myositis or pneumonitis. Initial symptoms may resemble an acute viral infection. Other common manifestations include arthralgias, jaundice, hepatomegaly, leucocytosis, and eosinophilia. The interval between the first drug exposure and symptoms is usually 2 to 4 weeks but has been reported in individuals receiving anticonvulsants for 3 or more months. If such signs and symptoms occur, the patient should be evaluated immediately. Phenytoin should be discontinued if an alternative aetiology for the signs and symptoms cannot be established, and appropriate supportive measures provided.

Patients at higher risk for developing HSS/DRESS include black patients, patients who have experienced this syndrome in the past (with phenytoin or other anticonvulsant drugs), patients who have a family history of this syndrome and immunosuppressed patients. The syndrome is more severe in previously sensitised individuals.

## **Serious Dermatologic Reactions**

Phenytoin can cause rare, serious skin adverse events such as exfoliative dermatitis, Stevens-Johnson syndrome (SJS), and toxic epidermal necrolysis (TEN), which can be fatal. Although serious skin reactions may occur without warning, patients should be alert for the signs and symptoms of skin rash and blisters, fever, itching and other signs and symptoms of HSS/DRESS (see **PRECAUTIONS, Hypersensitivity Syndrome/Drug Reaction with Eosinophilia and Systemic Symptoms**), and should seek medical advice from their physician immediately when observing any indicative signs or symptoms. The physician should advise the patient to discontinue treatment if the rash appears. If the rash is of a milder type (measles-like or scarlatiniform), therapy may be resumed after the rash has completely disappeared. If the rash recurs upon reinstatement of therapy, further phenytoin medication is contraindicated. The risk of serious skin reactions and other hypersensitivity reactions to phenytoin, including skin rash, SJS, TEN, hepatotoxicity, and HSS may be higher in black patients.

Studies in patients of Chinese ancestry have found a strong association between the risk of developing SJS/TEN and the presence of HLA-B\*1502, an inherited allelic variant of the human leucocyte antigen B (HLA-B) gene, in patients using carbamazepine. Limited evidence suggests that HLA-B\*1502 may be a risk factor for the development of SJS/TEN in patients of Asian ancestry taking drugs associated with SJS/TEN, including phenytoin. Consideration should be given to avoiding use of drugs associated with SJS/TEN, including phenytoin, in HLA-B\*1502-positive patients when alternative therapies are otherwise equally available.

Literature reports suggest that the combination of phenytoin, cranial irradiation and the gradual reduction of corticosteroids may be associated with the development of erythema multiforme, and/or SJS, and/or TEN.

Phenytoin and other hydantoin are contraindicated in patients who have experienced phenytoin hypersensitivity. Additionally caution should be exercised if using structurally similar compounds (e.g. barbiturates, succinimides, oxazolidinediones and other related compounds) in these same patients.

### **Hepatic Injury**

The main site of biotransformation of phenytoin is the liver.

Toxic hepatitis and liver damage have been reported and may, in rare cases, be fatal.

Cases of acute hepatotoxicity, including infrequent cases of acute hepatic failure, have been reported with phenytoin. These incidents usually occur within the first 2 months of treatment and may be associated with HSS/DRESS (see **PRECAUTIONS, Hypersensitivity Syndrome/Drug Reaction with Eosinophilia and Systemic Symptoms**). Patients with impaired liver function, elderly patients or those gravely ill, may show early signs of toxicity on standard dosage. Care should be exercised with dose adjustment in these patients.

The clinical course of acute phenytoin hepatotoxicity ranges from prompt recovery to fatal outcomes. In these patients with acute hepatotoxicity, phenytoin should be immediately discontinued and not re-administered.

The risk of hepatotoxicity and other hypersensitivity reactions to phenytoin may be higher in black patients.

### **Haematopoietic Effect**

Haematopoietic complications, some fatal, have occasionally been reported in association with administration of phenytoin. These have included thrombocytopenia, leucopenia, granulocytopenia, agranulocytosis, and pancytopenia with or without bone marrow suppression.

There have been a number of reports suggesting a relationship between phenytoin and the development of lymphadenopathy (local or generalised) including benign lymph node hyperplasia, pseudolymphoma, lymphoma, and Hodgkin's disease. Although a cause-and-effect relationship has not been established, the occurrence of lymphadenopathy indicates the need to differentiate such a condition from other types of lymph node pathology. Lymph node involvement may occur with or without signs and symptoms resembling HSS/DRESS (see **PRECAUTIONS, Hypersensitivity Syndrome/Drug Reaction with Eosinophilia and Systemic Symptoms**). In all cases of lymphadenopathy, follow-up observation for an extended period is indicated, and every effort should be made to achieve seizure control using alternative antiepileptic drugs.

While macrocytosis and megaloblastic anaemia have occurred, these conditions usually respond to folic acid therapy. If folic acid is added to phenytoin therapy, a decrease in seizure control may occur.

It is recommended that patients receiving long-term Dilantin therapy should undergo regular blood counts as serious haematological abnormalities have been reported (see **ADVERSE EFFECTS**).

### **Metabolic Effect**

In view of isolated reports associating phenytoin with exacerbation of porphyria, caution should be exercised in using this medication in patients suffering from this disease.

Hyperglycaemia, resulting from the drug's inhibitory effects on insulin release, has been reported. Phenytoin may also raise the serum glucose level in diabetic patients.

Hypoalbuminaemia, from any cause, may be potentially toxic through its effect on increasing unbound phenytoin levels.

### **Musculoskeletal Effect**

Phenytoin and other anticonvulsants that have been shown to induce the CYP450 enzyme are thought to affect bone mineral metabolism indirectly by increasing the metabolism of vitamin D<sub>3</sub>. This may lead to vitamin D deficiency and heightened risk of osteomalacia, bone fractures, osteoporosis, hypocalcaemia and hypophosphataemia in chronically treated epileptic patients.

### **Women of Childbearing Potential**

Phenytoin may cause fetal harm when administered to a pregnant woman. Prenatal exposure to phenytoin may increase the risks for congenital malformations and other adverse development outcomes (see **Use in pregnancy**).

### **Central Nervous System Effect**

Serum levels of phenytoin sustained above the optimal range may produce confusional states referred to as delirium, psychosis or encephalopathy, or rarely irreversible cerebellar dysfunction and/or cerebellar atrophy. Accordingly, at the first sign of acute toxicity, determination of plasma drug levels is recommended. Dose reduction of phenytoin therapy is indicated if plasma drug levels are excessive, if symptoms persist, termination of phenytoin therapy is recommended.

### **Use in Pregnancy (Category D)**

Phenytoin crosses the placenta in humans.

The risk of having an abnormal child as a result of antiepileptic medication is far outweighed by the dangers to the mother and fetus of uncontrolled epilepsy.

It is recommended that:

- Women on antiepileptic drugs (AEDs) receive pre-pregnancy counselling with regard to the risk of fetal abnormalities;
- AEDs should be continued during pregnancy and monotherapy should be used if possible at the lowest effective dose as risk of abnormality is greater in women taking combined medication;

- Folic acid supplementation (5 mg) should be commenced four weeks prior to and continue for twelve weeks after conception;
- Specialist prenatal diagnosis including detailed mid-trimester ultrasound should be offered.

Phenytoin should only be used in women of childbearing potential and pregnant women if the potential benefit outweighs the risk. When appropriate, counsel pregnant women and women of childbearing potential about alternative therapeutic options.

This drug taken during pregnancy has been associated with craniofacial defects, fingernail hypoplasia, developmental disability, growth retardation and less frequently, oral clefts and cardiac anomalies. This clinical pattern is sometimes called the 'fetal hydantoin syndrome'.

A number of reports suggest an association between the use of anticonvulsant drugs by women with epilepsy and a higher incidence of birth defects in children born to these women. The risk of a mother with epilepsy giving birth to a baby with an abnormality is about three times that of the normal population. Some of this risk is due to the anticonvulsant drugs taken.

It is important to note that antiepileptic drugs should not be discontinued in patients in whom the drug is administered to prevent major seizures, because of the strong possibility of precipitating status epilepticus with attendant hypoxia and threat to life. In individual cases where the severity and frequency of the seizure disorder are such that the removal of medication does not pose a serious threat to the patient, discontinuation of the drug may be considered prior to and during pregnancy, although it cannot be said with any confidence that even minor seizures do not pose some hazard to the developing embryo or fetus. The prescribing physician will wish to weigh these considerations in treating and counselling epileptic women of childbearing potential.

In addition to the reports of increased incidence of congenital malformations such as cleft lip/palate and heart malformations in children of women receiving phenytoin and other anticonvulsant drugs, there have been reports of a fetal hydantoin syndrome. This consists of prenatal dysmorphic facial features, fingernail and digit hypoplasia, developmental disability, growth retardation (including microcephaly) and mental deficiency in children born to mothers who have received phenytoin, barbiturates, alcohol or trimethadione. Similar clinical features are seen with intrauterine abnormalities due to other drugs that should form part of the differential diagnoses in fetal hydantoin syndrome.

There have been isolated reports of malignancies including neuroblastoma, in children whose mothers received phenytoin during pregnancy.

An increase in seizure frequency during pregnancy occurs in a high proportion of patients, because of altered phenytoin absorption or metabolism. Periodic measurement of serum phenytoin levels is particularly valuable in the management of a pregnant epileptic patient as a guide to an appropriate adjustment of dosage. However, postpartum restoration of the original dosage will probably be indicated.

Phenytoin also can cause coagulation defects with consequent risk of haemorrhage in the fetus and the newborn infant which may be preventable by the prophylactic administration of vitamin K to the mother prior to delivery.

Women of childbearing potential who are not planning a pregnancy should be advised on the use of effective contraception during treatment. Phenytoin may result in a failure of the therapeutic effect of hormonal contraceptives (see **INTERACTIONS WITH OTHER MEDICINES**).

### **Use in Lactation**

Breastfeeding is not recommended for women taking this drug because phenytoin appears to be secreted in low concentration in human milk. Phenytoin concentration in breast milk is approximately one-third of the corresponding maternal plasma concentration.

### **Use in the Elderly**

Phenytoin clearance tends to decrease with increasing age. Phenytoin dosing requirements are highly variable and must be individualised.

### **Effects on Ability to Drive and Use Machines**

Patients should be advised not to drive a car or operate potentially dangerous machinery until it is known that this medication does not affect their ability to engage in these activities.

### **Effects on Laboratory Tests**

Phenytoin may cause decreased serum levels of protein bound iodine (PBI). It may also produce lower than normal values for dexamethasone or metyrapone tests. Phenytoin may cause raised serum levels of glucose, alkaline phosphatase, and gamma glutamyl transpeptidase (GGT). Raised glucose levels appear to be due to inhibition of insulin secretion.

### **Effects on fertility**

Phenytoin has not been adequately assessed for effects on male or female fertility.

### **Genotoxicity**

Phenytoin was negative in the Ames test and in the in vitro clastogenicity assay in Chinese hamster ovary (CHO) cells. In studies reported in the literature, phenytoin was negative in the in vitro mouse lymphoma assay and the in vivo micronucleus assay in mouse. Phenytoin was clastogenic in the in vitro sister chromatid exchange assay in CHO cells.

### **Carcinogenicity**

In carcinogenicity studies, phenytoin was administered in the diet to mice (10, 25, or 45 mg/kg/day) and rats (25, 50, or 100 mg/kg/day) for 2 years. The incidences of hepatocellular tumors were increased in male and female mice at the highest dose. No increases in tumor incidence were observed in rats. The highest doses tested in these studies were associated with peak serum phenytoin levels below human therapeutic concentrations.

In carcinogenicity studies reported in literature, phenytoin was administered in the diet for 2 years at doses up to 300 ppm (approximately 60 mg/kg/day) and 600 ppm (approximately 160 mg/kg/day) to male and female mice respectively, and up to 2400 ppm (approximately 120 mg/kg/day) to rats. The incidence of hepatocellular tumors were increased in female mice at all but the lowest dose tested. No increases in tumor incidence were observed in rats. Phenytoin-induced hepatic tumors in mice may be secondary to hepatic enzyme induction in those species and are of uncertain clinical relevance.

## INTERACTIONS WITH OTHER MEDICINES

There are many drugs that may increase or decrease phenytoin levels or that phenytoin may affect. Mechanisms of drug interaction with phenytoin may be complex. In assessing drug-interactions, serum phenytoin concentrations and the clinical status of the patient will be helpful.

In general, phenytoin is a potent inducer of the hepatic cytochrome P450 microsomal isoenzymes CYP3A4, CYP2D6, CYP1A2, CYP2C9 and CYP2C19. However, a patient's susceptibility to enzyme-inducing interactions may be influenced by factors such as age, cigarette smoking, or the presence of liver disease. Phenytoin is metabolised primarily by CYP2C9 (major) and CYP2C19 (minor), thus several drugs may inhibit or induce the metabolism of phenytoin.

Oral phenytoin absorption may be reduced by a number of drugs. Phenytoin is highly plasma-protein bound and may be displaced by other drugs, increasing unbound ('free') phenytoin levels. Phenytoin is particularly susceptible to inhibitory drug interactions because it is subject to saturable metabolism. Inhibition of metabolism may produce significant increases in circulating phenytoin concentrations and enhance the risk of drug toxicity.

### Effects of Other Drugs on Phenytoin

**Table 2 Drugs That May Increase Phenytoin Serum Levels**

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
<i>Alcohol</i>	Alcohol (acute intake).
<i>Analgesic / Anti-inflammatory agents</i>	Salicylates.
<i>Antibacterial agents</i>	Chloramphenicol, erythromycin, isoniazid, sulfadiazine, sulfamethoxazole-trimethoprim, sulfonamides.
<i>Anticonvulsants</i>	Oxcarbazepine, sodium valproate, succinimides (ethosuximide), topiramate.
<i>Antifungal agents</i>	Amphotericin B, fluconazole, itraconazole, ketoconazole, miconazole, voriconazole.
<i>Antineoplastic agents</i>	Capecitabine**, fluorouracil**.
<i>Antiplatelet agents</i>	Clopidogrel.
<i>Benzodiazepines / Psychotropic</i>	Chlordiazepoxide, diazepam, disulfiram,

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
<i>agents</i>	methylphenidate, trazodone.
<i>Calcium channel blockers / Cardiovascular agents</i>	Amiodarone, diltiazem, nifedipine, ticlopidine.
<i>H2-antagonists</i>	Cimetidine.
<i>HMG-CoA reductase inhibitors</i>	Fluvastatin.
<i>Hormones</i>	Estrogens.
<i>Immunosuppressant drugs</i>	Tacrolimus.
<i>Oral hypoglycaemic agents</i>	Tolbutamide.
<i>Proton pump inhibitors</i>	Omeprazole.
<i>Serotonin re-uptake inhibitors</i>	Fluoxetine, fluvoxamine, sertraline.

\* This list is not intended to be inclusive or comprehensive. Individual drug labels should be consulted.

\*\* Increased phenytoin plasma concentrations have been reported during concomitant use of phenytoin with capecitabine or its metabolite fluorouracil (5FU). Formal interaction studies between phenytoin and capecitabine have not been conducted, but the mechanism of interaction is presumed to be inhibition of the CYP2C9 isoenzyme system by capecitabine. Patients taking phenytoin concomitantly with capecitabine or fluorouracil should be regularly monitored for increased phenytoin plasma levels.

**Table 3 Drugs That May Decrease Phenytoin Serum Levels**

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
<i>Alcohol</i>	Alcohol (chronic intake).
<i>Antibacterial agents / fluoroquinones</i>	Ciprofloxacin, rifampicin.
<i>Anticonvulsants</i>	Vigabatrin.
<i>Antineoplastic agent</i>	Bleomycin, carboplatin, cisplatin, doxorubicin, methotrexate.
<i>Antiulcer agents</i>	Sucralfate.
<i>Antiretrovirals</i>	Fosamprenavir, nelfinavir**, ritonavir.
<i>Bronchodilators</i>	Theophylline.
<i>Folic acid</i>	Folic acid.
<i>Hyperglycaemic agents</i>	Diazoxide.
<i>St John's wort</i>	<i>Hypericum perforatum</i> (St John's wort).

\* This list is not intended to be inclusive or comprehensive. Individual drug labels should be consulted.

\*\* A pharmacokinetic interaction study between nelfinavir and phenytoin both administered orally showed that nelfinavir reduced AUC values of phenytoin (total) and free phenytoin by 29% and 28% respectively. Therefore, phenytoin concentration should be monitored during co-administration with nelfinavir, as nelfinavir may reduce phenytoin plasma concentration.

Calcium ions may interfere with the absorption of phenytoin. Ingestion times of phenytoin and antacid preparations containing calcium should be staggered in patients with low serum phenytoin levels to prevent absorption problems.

**Table 4 Drugs That May Either Increase or Decrease Phenytoin Serum Levels**

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
<i>Antibacterial agents</i>	Ciprofloxacin.
<i>Anticonvulsants**</i>	Carbamazepine, phenobarbital, sodium valproate, valproic acid.
<i>Antineoplastic agents</i>	Antineoplastic agents.
<i>Psychotropic agents</i>	Chlordiazepoxide, diazepam, phenothiazines.

\* This list is not intended to be inclusive or comprehensive. Individual drug labels should be consulted.

\*\* The effect of phenytoin on carbamazepine, phenobarbital, valproic acid and sodium valproate serum levels is unpredictable.

### Effect of Phenytoin on Other Drugs

**Table 5 Drugs Whose Serum Levels and/or Effects May be Altered by Phenytoin**

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
<i>Antibacterial agents</i>	Doxycycline, rifampicin, tetracycline.
<i>Anticonvulsants</i>	Carbamazepine, lamotrigine, phenobarbital, sodium valproate, valproic acid.
<i>Antifungal agents</i>	Azoles, posaconazole, voriconazole.
<i>Anthelmintics</i>	Albendazole, praziquantel.
<i>Antineoplastic agents</i>	Teniposide.
<i>Antiretrovirals</i>	Delavirdine, efavirenz, fosamprenavir, indinavir, lopinavir/ritonavir, ritonavir, saquinavir.
<i>Bronchodilators</i>	Theophylline.
<i>Calcium channel blockers / Cardiovascular agents</i>	Digitoxin, digoxin, disopyramide, mexiletine, nicardipine, nimodipine, quinidine, verapamil.
<i>Corticosteroids</i>	Corticosteroids.
<i>Coumarin anticoagulants</i>	Warfarin.
<i>Ciclosporin</i>	Ciclosporin.
<i>Diuretics</i>	Furosemide.
<i>HMG-CoA reductase inhibitors</i>	Atorvastatin, fluvastatin, simvastatin.
<i>Hormones</i>	Estrogens, oral contraceptives (see <b>PRECAUTIONS: Women of Childbearing Potential and Use in</b>

<b>Drug Classes</b>	<b>Drugs in each Class (such as)*</b>
	<b>Pregnancy).</b>
<i>Hyperglycaemic agents</i>	Diazoxide.
<i>Immunosuppressant drugs</i>	Immunosuppressant drugs.
<i>Neuromuscular blocking agents</i>	Cisatracurium, pancuronium, rocuronium, vecuronium.
<i>Opioid analgesics</i>	Methadone.
<i>Oral hypoglycaemic agents</i>	Chlorpropamide, glibenclamide, tolbutamide.
<i>Psychotropic agents / Antidepressants</i>	Clozapine, paroxetine, quetiapine, sertraline.
<i>Vitamin D</i>	Vitamin D.
<i>Folic acid</i>	Folic acid.

\* This list is not intended to be inclusive or comprehensive. Individual drug labels should be consulted.

### **Seizure Threshold Lowering Drugs**

Although not a pharmacokinetic drug interaction, antidepressants, antipsychotics, tramadol and other seizure threshold lowering drugs may precipitate seizures in susceptible patients by lowering convulsive threshold. Phenytoin dosage may need to be adjusted.

### **Drug-Enteral Feeding/Nutritional Preparations Interaction**

The oral absorption of phenytoin suspension can be reduced substantially by up to 80% by concurrent administration of enteral feeding preparations and/or related nutritional supplements. Conversely, when enteral feedings are halted, phenytoin levels may rise substantially. If the patient can receive intermittent feedings, it is crucial that phenytoin doses be administered at least two hours following a feeding and that the next feeding be delayed until at least two hours after the phenytoin dose is administered. Patients who must receive continuous enteral feedings should probably receive phenytoin intravenously. Any patients receiving phenytoin orally through a feeding tube should have the suspension diluted prior to administration and the tubing flushed following administration. Serum phenytoin levels should be monitored and the dosage should be adjusted to achieve therapeutic concentrations.

## **ADVERSE EFFECTS**

### **Body as a Whole**

Anaphylactoid reaction and anaphylaxis.

### **Gastrointestinal System**

Nausea, vomiting and constipation. To prevent gastric irritation due to alkalinity, Dilantin should be taken with at least half a glass of water. Gastric irritation may often be minimised by administering Dilantin during or following meals or by using Dilantin Suspension.

## **Haematopoietic System**

Some fatal haematopoietic complications have occasionally been reported in association with the administration of phenytoin. Included in these are thrombocytopenia, leucopenia, granulocytopenia, agranulocytosis and pancytopenia with or without bone marrow suppression. Macrocytosis and megaloblastic anaemia have also occurred, these conditions usually respond to folic acid therapy.

Lymphadenopathy including benign lymph node hyperplasia, pseudolymphoma, lymphoma and Hodgkin's disease have been reported (see **PRECAUTIONS, Haematopoietic Effect**).

## **Central Nervous System**

The most common manifestations encountered with phenytoin therapy are referable to this system and are usually dose-related. These include nystagmus, ataxia, slurred speech, decreased coordination, and mental confusion. Cerebellar atrophy has been reported and appears more likely in settings of elevated phenytoin levels and/or long-term phenytoin use (see **PRECAUTIONS, Central Nervous System Effect**). Cases of dizziness, vertigo, insomnia, transient nervousness, motor twitchings, headache, paraesthesia and somnolence have also been reported.

There have also been rare reports of phenytoin induced dyskinesias, including chorea, dystonia, tremor and asterixis, similar to those induced by phenothiazine and other neuroleptic drugs. A predominantly sensory peripheral polyneuropathy has been observed in patients receiving long-term phenytoin therapy.

## **Immunologic**

HSS/DRESS (which may include, but is not limited to, symptoms such as arthralgias, eosinophilia, fever, liver dysfunction, lymphadenopathy or rash), systemic lupus erythematosus, periarteritis nodosa and immunoglobulin abnormalities (see **PRECAUTIONS, Hypersensitivity Syndrome/Drug Reaction with Eosinophilia and Systemic Symptoms**).

## **Investigations**

Thyroid function test abnormal.

## **Connective Tissue System**

Coarsening of the facial features, enlargement of the lips, gingival hyperplasia, hypertrichosis and Peyronie's Disease.

## **Musculoskeletal System**

Bone fractures and osteomalacia have been associated with long-term (>10 years) use of phenytoin by patients with chronic epilepsy. Osteoporosis and other disorders of bone metabolism such as hypocalcaemia, hypophosphataemia and decreased serum levels of vitamin D metabolites have also been reported.

## **Dermatological System**

Dermatological manifestations sometimes associated with fever have included scarlatiniform or morbilliform rashes. The latter case is the most common with other types of dermatitis being more rare. In general, rashes are more frequent in children and young adults. More serious forms that may be fatal have also been reported and they include bullous, exfoliative, or other purpuric dermatitis, lupus erythematosus, SJS and TEN (see **PRECAUTIONS, Serious Dermatologic Reactions**).

## **Hepatic System**

Potentially fatal cases of acute hepatic failure, toxic hepatitis and liver damage may occur (see **PRECAUTIONS, Hepatic Injury**). This effect may be the result of a hypersensitivity reaction.

## **Special Senses**

Taste perversion.

## **Miscellaneous**

Gingival hyperplasia occurs frequently and its incidence may be reduced by good oral hygiene, including gum massage, frequent brushing and appropriate dental care.

Hirsutism.

## **DOSAGE AND ADMINISTRATION**

Serum concentrations should be monitored and care should be taken when switching a patient from the sodium salt to the free acid form.

Dilantin capsules (30 mg, 100 mg) are formulated with the sodium salt of phenytoin.

The free acid form of phenytoin is used in Dilantin Infatabs (50 mg) and Dilantin Paediatric Suspension (30 mg/5 mL).

Because there is approximately an 8% increase in drug content with the free form over that of the sodium salt, dosage adjustments and serum level monitoring may be necessary when switching from a product formulated with the free acid to a product formulated with the sodium salt and vice versa.

## **General**

Dosage should be individualised to obtain maximum benefit. In some cases, serum blood level determinations may be necessary for optimal dosage adjustments. Serum levels between 10 µg/mL and 20 µg/mL are considered to be clinically effective. With the recommended dosage, a period of at least 7 to 10 days may be required to achieve therapeutic blood levels of Dilantin, unless therapy is initiated with a loading dose. After the initial dose has been prescribed, plasma levels should be determined and the dosage adjusted if necessary to obtain

a level in the therapeutic range; 10 µg/mL to 20 µg/mL (40 µmoles/L to 80 µmoles/L). Because phenytoin is hydroxylated in the liver by an enzyme system which is saturable, at high plasma levels small incremental doses may increase the half-life and produce very substantial increases in serum levels, when these are in the upper range.

### **Oral Administration**

Although phenytoin has a relatively long plasma half-life, thrice daily dosing may reduce the incidence of gastric irritation since lower doses can be administered with thrice daily dosing as compared with twice daily dosing. Recent studies suggest that a better correlation is achieved between plasma levels and dose by expressing the latter on a body-weight basis.

### ***Adult***

Initiate therapy with 4 mg/kg/day to 5 mg/kg/day in 2 to 3 divided doses and assess plasma levels. A further upward dosage adjustment may be required to a maximum of 600 mg/day, dosage increments should be made at about 2 week intervals. Plasma phenytoin levels should be monitored should higher doses be required.

An initial dose of 6 mg/kg/day to 7 mg/kg/day would be more likely to ensure therapeutic levels however, there is a risk that such a dose may achieve levels exceeding 20 µg/mL and increase the risk of toxicity.

### ***Paediatric***

Initiate therapy with 5 mg/kg/day in 2 to 3 equally divided doses not to exceed 300 mg daily. A recommended daily maintenance dosage is usually 4 mg/kg to 8 mg/kg. Children over 6 years may require the minimum adult dose (300 mg/day).

Paediatric dosage forms available include Dilantin Chewable Infatabs and Dilantin Paediatric Suspension.

Dilantin Paediatric Suspension is not for parenteral use.

### ***Dosing in Special Populations***

*Patients with Renal or Hepatic Disease:* (see **PRECAUTIONS, General**).

*Elderly Patients:* Phenytoin clearance is decreased slightly in elderly patients and lower or less frequent dosing may be required (see **PRECAUTIONS, Use in the Elderly**).

## **OVERDOSAGE**

### **Signs and Symptoms**

There are marked variations among individuals with respect to phenytoin plasma levels where toxicity may occur. Nystagmus or lateral gaze, usually appears at 20 µg/mL, ataxia at 30 µg/mL, dysarthria and lethargy appear when the plasma concentration is over 40 µg/mL, but as high a concentration as 50 µg/mL has been reported without evidence of toxicity. As much as 25 times the therapeutic dose has been taken to result in a serum concentration above

100 µg/mL with complete recovery. The lethal dose in children is not known. The lethal dose in adults is estimated to be 2 g to 5 g.

The cardinal initial symptoms are nystagmus, ataxia, dysarthria and CNS depression. Other signs that may be seen are tremor, hyperreflexia, somnolence, drowsiness, lethargy, hallucinations, confusion, mental status changes, slurred speech, blurred vision, nausea, vomiting, choreoathetosis, dyskinesias, hyperglycaemia and mild hypoglycaemia. Severe poisoning may result in respiratory depression. Cardiotoxicity has not been reported with oral overdoses. Irreversible cerebellar dysfunction and atrophy have been reported as a delayed effect following severe overdoses. The patient may become comatose and hypotensive. Death is due to respiratory and circulatory depression.

### **Pharmacokinetic Information**

In overdose settings, saturation of the hepatic hydroxylation system occurs and zero order kinetics predominate. Elimination follows a Michaelis-Menten model with a prolonged half-life. As phenytoin is continually excreted, elimination changes from zero order to first order kinetics and drug levels decrease more.

Serial plasma phenytoin concentrations should be monitored. In acute overdose, peak levels are frequently delayed for 24 to 48 hours, and occasionally as long as 7 days.

The proportion of phenytoin in plasma not bound to protein is an important measure of potential toxicity with free phenytoin levels of <1.5 µg/mL indicating no signs of toxicity; 1.5 µg/mL to 5 µg/mL seen with mild to moderate intoxication; and levels above 5 µg/mL associated with severe intoxication.

### **Treatment of Overdosage**

Treatment is non-specific since there is no known antidote. Most cases of overdosage may be managed conservatively with symptomatic and supportive care. Signs and symptoms of toxicity may persist up to 7 to 10 days after ingestion.

Phenytoin is poorly absorbed in the stomach, therefore although routine use of activated charcoal is not recommended, it may be considered in the rare patient with a life threatening ingestion. In patients who are not fully conscious or have impaired gag reflex, consideration should be given to administering activated charcoal via a nasogastric tube, once the airway is protected. Administration of a further dose of activated charcoal may be considered in patients with rising serum phenytoin levels or worsening clinical condition despite initial decontamination.

Peritoneal dialysis, diuresis, haemodialysis, plasmapheresis, haemofiltration and total exchange transfusion may be of little benefit although the latter has been used in the treatment of severe intoxication in children.

In acute overdosage the possibility of other CNS depressants, including alcohol, should be borne in mind.

Contact the Poisons Information Centre on 13 11 26 for advice on the management of an overdose.

## **PRESENTATION AND STORAGE CONDITIONS**

### **Capsules**

Capsules 30 mg and 100 mg are packaged in HDPE bottles with a child-resistant polypropylene cap.

100 mg (opaque hard gelatin capsule with white body/orange lid, marked 'PARKE DAVIS' on one end and 'P-D 100' on the other): 200 capsules.

30 mg (opaque hard gelatin capsule with white body/white lid, marked 'PARKE DAVIS' on one end and 'P-D 30' on the other): 200 capsules.

### **Infatabs**

Infatabs 50 mg are packaged in HDPE bottles with a child-resistant polypropylene cap.

50 mg (yellow, triangular, spearmint-flavoured chewable tablets with flat sides, bevelled edge, breaking line on one side and 'P-D 007' imprinted on the other): 200 tablets.

### **Paediatric Suspension**

Paediatric Suspension is packaged in an amber glass bottle (Type III) fitted with either an aluminium roll-on cap or a white, child-resistant, tamper-evident polypropylene cap lined with Triseal (polyethylene) or Melinex (polyester) wad.

30 mg/5 mL (reddish-pink suspension): 500 mL.

### **Storage**

*Capsules* – Store below 30°C.

*Infatabs* – Store below 30°C.

*Paediatric Suspension* – Store below 25°C.

## **NAME AND ADDRESS OF THE SPONSOR**

Pfizer Australia Pty Ltd  
ABN 50 008 422 348  
38-42 Wharf Road  
West Ryde NSW 2114.

## **POISON SCHEDULE OF THE MEDICINE**

Prescription Only Medicine (Schedule 4).

**DATE OF FIRST INCLUSION IN THE AUSTRALIAN REGISTER OF THERAPEUTIC GOODS**

20 September 1991.

**DATE OF MOST RECENT AMENDMENT**

02 February 2018

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