

HIGHLIGHTS OF PRESCRIBING INFORMATION

These highlights do not include all the information needed to use METHYLIN® safely and effectively. See full prescribing information for METHYLIN®.

METHYLIN® (methylphenidate hydrochloride) oral solution, CII
Initial U.S. Approval: 1955

WARNING: ABUSE AND DEPENDENCE

See full prescribing information for complete boxed warning.

- CNS stimulants, including Methylin, other methylphenidate-containing products, and amphetamines, have a high potential for abuse and dependence. (5.1, 9.2, 9.3)
- Assess the risk of abuse prior to prescribing and monitor for signs of abuse and dependence while on therapy. (5.1, 9.2)

INDICATIONS AND USAGE

Methylin is a central nervous system (CNS) stimulant indicated for the treatment of:

- Attention Deficit Hyperactivity Disorder (ADHD) in adults and pediatric patients 6 years of age and older (1)
- Narcolepsy (1)

DOSAGE AND ADMINISTRATION

- *Pediatric patients 6 years and older:* Starting dose is 5 mg twice daily (before breakfast and lunch); increase the dose 5 mg to 10 mg weekly; daily dosage above 60 mg is not recommended. (2.2)
- *Adults:* Administer in divided doses 2 or 3 times daily, preferably 30 to 45 minutes before meals. Average dosage is 20 to 30 mg daily. Maximum recommended daily dosage is 60 mg. (2)

DOSAGE FORMS AND STRENGTHS

Oral solution: 5 mg per 5 mL and 10 mg per 5 mL. (3)

CONTRAINDICATIONS

- Known hypersensitivity to methylphenidate or other components of Methylin (4)
- Concurrent treatment with a monoamine oxidase inhibitor (MAOI), or use of an MAOI within the preceding 14 days (4)

WARNINGS AND PRECAUTIONS

- *Serious Cardiovascular Reactions:* Sudden death has been reported in association with CNS stimulant treatment at recommended doses in pediatric patients with structural cardiac abnormalities or other serious heart problems. In adults, sudden death, stroke, and myocardial infarction have been reported. Avoid use in patients with known structural cardiac abnormalities, cardiomyopathy, serious heart arrhythmias, or coronary artery disease. (5.2)
- *Blood Pressure and Heart Rate Increases:* Monitor blood pressure and pulse. Consider the benefits and risks in patients for whom an increase in blood pressure or heart rate would be problematic. (5.3)
- *Psychiatric Adverse Reactions:* Use of stimulants may cause psychotic or manic symptoms in patients with no prior history or exacerbation of symptoms in patients with no prior history, or exacerbation of symptoms in patients with pre-existing psychiatric illness. Evaluate for bipolar disorder prior to Methylin use. (5.4)
- *Priapism:* Cases of painful and prolonged penile erections and priapism have been reported with methylphenidate products. Immediate medical attention should be sought if signs or symptoms of painful or prolonged penile erections or priapism are observed. (5.5)
- *Peripheral Vasculopathy, Including Raynaud's Phenomenon:* Stimulants used to treat ADHD are associated with peripheral vasculopathy, including Raynaud's phenomenon. Careful observation for digital changes is necessary during treatment with ADHD stimulants. (5.6)
- *Long-Term Suppression of Growth:* Monitor height and weight at appropriate intervals in pediatric patients. (5.7)

ADVERSE REACTIONS

Common adverse reactions: tachycardia, palpitations, headache, insomnia, anxiety, hyperhidrosis, weight loss, decreased appetite, dry mouth, nausea, and abdominal pain. (6)

To report SUSPECTED ADVERSE REACTIONS contact Shionogi Inc. at 1-800-849-9707 or FDA at 1-800-FDA-1088 or www.fda.gov/medwatch.

DRUG INTERACTIONS

- Antihypertensive Drugs: Monitor blood pressure. Adjust dosage of antihypertensive drug as needed. (7.1)

See 17 for Medication Guide.

Revised: 7/2021

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FULL PRESCRIBING INFORMATION

WARNING: ABUSE AND DEPENDENCE

CNS stimulants, including Methylin, other methylphenidate-containing products, and amphetamines, have a high potential for abuse and dependence. Assess the risk of abuse prior to prescribing, and monitor for signs of abuse and dependence while on therapy [see Warnings and Precautions (5.1), Drug Abuse and Dependence (9.2, 9.3)].

1 INDICATIONS AND USAGE

Methylin is indicated for the treatment of:

- Attention Deficit Hyperactivity Disorder (ADHD) in adults and pediatric patients 6 years of age and older
- Narcolepsy

2 DOSAGE AND ADMINISTRATION

2.1 Pretreatment Screening

Prior to initiating treatment with Methylin, assess for the presence of cardiac disease (i.e., perform a careful history including family history of sudden death or ventricular arrhythmia, and physical examination) [see Warnings and Precautions (5.2)].

Assess the risk of abuse prior to prescribing, and monitor for signs of abuse and dependence while on therapy. Maintain careful prescription records, educate patients about abuse, monitor for signs of abuse and overdose, and periodically re-evaluate the need for Methylin use [see Boxed Warning, Warnings and Precautions (5.1), Drug Abuse and Dependence (9)].

2.2 General Dosing Information

Pediatric Patients 6 years of Age and Older

The recommended starting dosage is 5 mg orally twice daily before breakfast and lunch (preferably 30 to 45 minutes before meals). Increase the dosage gradually, in increments of 5 mg to 10 mg weekly. Daily dosage above 60 mg is not recommended.

Adults

Administer orally in divided doses 2 or 3 times daily, preferably 30 to 45 minutes before meals. The maximum recommended daily dose is 60 mg. The average dosage is 20 to 30 mg daily. For adult patients who are unable to sleep if medication is taken late in the day, administer the last dose before 6 p.m.

Pharmacological treatment of ADHD may be needed for extended periods. Periodically re-evaluate the long-term use of Methylin, and adjust the dosage as needed.

2.3 Dosage Reduction and Discontinuation

If paradoxical aggravation of symptoms or other adverse reactions occur, reduce dosage, or, if necessary, discontinue Methylin. Methylin should be periodically discontinued to assess the pediatric patient's condition. If improvement is not observed after appropriate dosage adjustment over a one-month period, discontinue Methylin.

3 DOSAGE FORMS AND STRENGTHS

Methylin oral solution is a colorless, grape flavored liquid available in a 500 mL bottle in the following strengths:

- 5 mg per 5 mL
- 10 mg per 5 mL

4 CONTRAINDICATIONS

Methylin is contraindicated in patients:

- with known hypersensitivity to methylphenidate or other components of Methylin. Hypersensitivity reactions such as angioedema and anaphylactic reactions have been reported in patients treated with methylphenidate [see Adverse Reactions (6)].
- receiving concomitant treatment with monoamine oxidase inhibitors (MAOIs), or within 14 days following discontinuation of treatment with an MAOI, because of the risk of hypertensive crises [see Drug Interactions (7)].

5 WARNINGS AND PRECAUTIONS

5.1 Potential for Abuse and Dependence

CNS stimulants, including Methylin, other methylphenidate-containing products, and amphetamines, have a high potential for abuse and dependence. Assess the risk of abuse prior to prescribing, and monitor for signs of abuse and dependence while on therapy [see Boxed Warning, Drug Abuse and Dependence (9.2, 9.3)].

5.2 Serious Cardiovascular Reactions

Sudden death, stroke and myocardial infarction have been reported in adults with CNS stimulant treatment at recommended doses. Sudden death has been reported in pediatric patients with structural cardiac abnormalities and other serious heart problems taking CNS stimulants at recommended doses for ADHD. Avoid use in patients with known structural cardiac abnormalities, cardiomyopathy, serious heart rhythm abnormalities, coronary artery disease, and other serious heart problems. Further evaluate patients who develop exertional chest pain, unexplained syncope, or arrhythmias during Methylin treatment.

5.3 Blood Pressure and Heart Rate Increases

CNS stimulants cause an increase in blood pressure (mean increase approximately 2 to 4 mmHg) and heart rate (mean increase approximately 3 to 6 bpm). Individuals may have larger increases. Monitor all patients for hypertension and tachycardia.

5.4 Psychiatric Adverse Reactions

Exacerbation of Pre-Existing Psychosis

CNS stimulants may exacerbate symptoms of behavior disturbance and thought disorder in patients with a pre-existing psychotic disorder.

Induction of a Manic Episode in Patients with Bipolar Illness

CNS stimulants may induce a manic or mixed mood episode in patients. Prior to initiating treatment, screen patients for risk factors for developing a manic episode (e.g., comorbid or history of depressive symptoms or a family history of suicide, bipolar disorder, or depression).

New Psychotic or Manic Symptoms

CNS stimulants, at recommended doses, may cause psychotic or manic symptoms (e.g., hallucinations, delusional thinking, or mania) in patients without a prior history of psychotic illness or mania. If such symptoms occur, consider discontinuing Methylin. In a pooled analysis of multiple short-term, placebo-controlled studies of CNS stimulants, psychotic or manic symptoms occurred in approximately 0.1% of CNS stimulant-treated patients, compared to 0 in placebo-treated patients.

5.5 Priapism

Prolonged and painful erections, sometimes requiring surgical intervention, have been reported with methylphenidate products in both pediatric and adult patients. Priapism was not reported with drug initiation but developed after some time on the drug, often subsequent to an increase in dose. Priapism has also appeared during a period of drug withdrawal (drug holidays or during discontinuation). Patients who develop abnormally sustained or frequent and painful erections should seek immediate medical attention.

5.6 Peripheral Vasculopathy, Including Raynaud's Phenomenon

Stimulants used to treat ADHD, including Methylin, are associated with peripheral vasculopathy, including Raynaud's phenomenon. Signs and symptoms are usually intermittent and mild; however, very rare sequelae include digital ulceration and/or soft tissue breakdown. Effects of peripheral vasculopathy, including Raynaud's phenomenon, were observed in postmarketing reports at different times and at therapeutic doses in all age groups throughout the course of treatment. Signs and symptoms generally improve after reduction in dose or discontinuation of drug. Careful observation for digital changes is necessary during treatment with ADHD stimulants. Further clinical evaluation (e.g., rheumatology referral) may be appropriate for certain patients.

5.7 Long-Term Suppression of Growth

CNS stimulants have been associated with weight loss and slowing of growth rate in pediatric patients.

Careful follow-up of weight and height in children ages 7 to 10 years who were randomized to either methylphenidate or non-medication treatment groups over 14 months, as well as in naturalistic subgroups of newly methylphenidate-treated and non-medication treated children over 36 months (to the ages of 10 to 13 years), suggests that consistently medicated children (i.e., treatment for 7 days per week throughout the year) have a temporary slowing in growth rate (on average, a total of about 2 cm less growth in height and 2.7 kg less growth in weight over 3 years), without evidence of growth rebound during this period of development.

Closely monitor growth (weight and height) in pediatric patients treated with stimulants, including Methylin. Patients who are not growing or gaining height or weight as expected may need to have their treatment interrupted. The safety and effectiveness of Methylin have not been established in pediatric patient less than 6 years of age.

6 ADVERSE REACTIONS

The following adverse reactions are discussed in more detail in other sections of the labeling:

- Abuse and Dependence [*see Warnings and Precautions (5.1), Drug Abuse and Dependence (9.2, 9.3)*]
- Known hypersensitivity to methylphenidate or other components of Methylin [*see Contraindications (4)*]
- Hypertensive crisis when used concomitantly with monoamine oxidase inhibitors [*see Contraindications (4), Drug Interactions (7)*]
- Serious cardiovascular reactions [*see Warnings and Precautions (5.2)*]
- Blood pressure and heart rate increases [*see Warnings and Precautions (5.3)*]
- Psychiatric adverse reactions [*see Warnings and Precautions (5.4)*]
- Priapism [*see Warnings and Precautions (5.5)*]
- Peripheral vasculopathy, including Raynaud's phenomenon [*see Warnings and Precautions (5.6)*]
- Long-term suppression of growth [*see Warnings and Precautions (5.7)*]

The following adverse reactions associated with the use of methylphenidate containing products were identified in clinical studies, postmarketing reports, or literature. Because some of these reactions were reported voluntarily from a population of uncertain size, it is not always possible to reliably estimate their frequency or establish a causal relationship to drug exposure.

Infections and infestations: nasopharyngitis

Blood and the lymphatic system disorders: leukopenia, thrombocytopenia, anemia, pancytopenia

Immune system disorders: hypersensitivity reactions, including angioedema and anaphylaxis, auricular swelling, bullous conditions, eruptions, exanthemas

Metabolism and nutrition disorders: decreased appetite, reduced weight gain and suppression of growth during prolonged use in pediatric patients

Psychiatric disorders: insomnia, anxiety, restlessness, agitation, psychosis (sometimes with visual and tactile hallucinations), depressed mood, affect lability, mania, disorientation, libido changes

Nervous system disorders: headache, dizziness, tremor, dyskinesia including choreoathetoid movements, drowsiness, convulsions, cerebral arteritis and/or occlusion, serotonin syndrome in combination with serotonergic drugs, migraine

Eye disorders: blurred vision, difficulties in visual accommodation, diplopia, mydriasis

Cardiac disorders: tachycardia, palpitations, increased blood pressure, arrhythmias, angina pectoris, sudden cardiac death, myocardial infarction, bradycardia, extrasystole

Respiratory, thoracic and mediastinal disorders: cough, pharyngolaryngeal pain, dyspnea

Gastrointestinal disorders: dry mouth, nausea, vomiting, abdominal pain, dyspepsia, diarrhea

General disorders: fatigue, hyperpyrexia

Hepatobiliary disorders: abnormal liver function, ranging from transaminase elevation to severe hepatic injury

Skin and subcutaneous tissue disorders: hyperhidrosis, pruritus, urticaria, exfoliative dermatitis, scalp hair loss, erythema multiforme rash, thrombocytopenic purpura angioneurotic edema, erythema, fixed drug eruption

Musculoskeletal and connective tissue disorders: arthralgia, muscle cramps, rhabdomyolysis, myalgia, muscle twitching

Renal and urinary disorders: hematuria

Reproductive system and breast disorders: gynecomastia

Urogenital disorders: priapism

Vascular disorders: peripheral coldness, Raynaud’s phenomenon

Investigations: weight loss

7 DRUG INTERACTIONS

7.1 Clinically Important Drug Interactions with Methylin

Table 1 presents clinically important drug interactions with Methylin.

Table 1: Clinically Important Drug Interactions with Methylin

Monoamine Oxidase Inhibitors (MAOI)	
<i>Clinical Impact:</i>	Concomitant use of MAOIs and CNS stimulants, including Methylin, can cause hypertensive crisis. Potential outcomes include death, stroke, myocardial infarction, aortic dissection, ophthalmological complications, eclampsia, pulmonary edema, and renal failure [see <i>Contraindications (4)</i>].
<i>Intervention:</i>	Concomitant use of Methylin with monoamine oxidase inhibitors (MAOIs) or within 14 days after discontinuing MAOI treatment is contraindicated.
Antihypertensive Drugs	
<i>Clinical Impact:</i>	Methylin may decrease the effectiveness of drugs used to treat hypertension [see <i>Warnings and Precautions (5.3)</i>].
<i>Intervention:</i>	Monitor blood pressure and adjust the dosage of the antihypertensive drug as needed.
Risperidone	
<i>Clinical Impact:</i>	Combined use of methylphenidate with risperidone when there is a change, whether an increase or decrease, in dosage of either or both medications, may increase the risk of extrapyramidal symptoms (EPS).
<i>Intervention:</i>	Monitor for signs of EPS.

8 USE IN SPECIFIC POPULATIONS

8.1 Pregnancy

Pregnancy Exposure Registry

There is a pregnancy exposure registry that monitors pregnancy outcomes in women exposed to ADHD medications, including Methylin, during

pregnancy. Healthcare providers are encouraged to register patients by calling the National Pregnancy Registry for Psychostimulants at 1-866-961-2388.

Risk Summary

Published studies and postmarketing reports on methylphenidate use during pregnancy have not identified a drug-associated risk of major birth defects, miscarriage or adverse maternal or fetal outcomes. There may be risks to the fetus associated with the use of CNS stimulants use during pregnancy (*see Clinical Considerations*).

No effects on morphological development were observed in embryo-fetal development studies with oral administration of methylphenidate to pregnant rats and rabbits during organogenesis at doses up to 12 and 19 times, respectively, the maximum recommended human dose (MRHD) of 60 mg/day given to adults on a mg/m² basis. However, spina bifida was observed in rabbits at a dose 65 times the MRHD given to adults. A decrease in pup body weight was observed in a pre- and post-natal development study with oral administration of methylphenidate to rats throughout pregnancy and lactation at doses 7 times the MRHD given to adults (*see Data*).

The estimated background risk of major birth defects and miscarriage for the indicated population is unknown. All pregnancies have a background risk of birth defect, loss, or other adverse outcomes. In the U.S. general population, the estimated background risk of major birth defects and miscarriage in clinically recognized pregnancies is 2% to 4% and 15% to 20%, respectively.

Clinical Considerations

Fetal/Neonatal Adverse Reactions

CNS stimulants, such as Methylin, can cause vasoconstriction and thereby decrease placental perfusion. No fetal and/or neonatal adverse reactions have been reported with the use of therapeutic doses of methylphenidate during pregnancy; however, premature delivery and low birth weight infants have been reported in amphetamine-dependent mothers.

Data

Animal Data

In embryo-fetal development studies conducted in rats and rabbits, methylphenidate was administered orally at doses of up to 75 and 200 mg/kg/day, respectively, during the period of organogenesis. Malformations (increased incidence of fetal spina bifida) were observed in rabbits at the highest dose, which is approximately 65 times the MRHD of 60 mg/day given to adults on a mg/m² basis. The no effect level for embryo-fetal development in rabbits was 60 mg/kg/day (19 times the MRHD given to adults on a mg/m² basis). There was no evidence of morphological development effects in rats, although increased incidences of fetal skeletal variations were seen at the highest dose level (12 times the MRHD of 60 mg/day given to adults on a mg/m² basis), which was also maternally toxic. The no effect level for embryo-fetal development in rats was 25 mg/kg/day (4 times the MRHD on a mg/m² basis). When methylphenidate was administered to rats throughout pregnancy and lactation at doses of up to 45 mg/kg/day, offspring body weight gain was decreased at the highest dose (7 times the MRHD of 60 mg/day given to adults on a mg/m² basis), but no other effects on postnatal development were observed. The no effect level for pre- and postnatal development in rats was 15 mg/kg/day (~2 times the MRHD given to adults on a mg/m² basis).

8.2 Lactation

Risk Summary

Limited published literature, based on milk sampling from seven mothers reports that methylphenidate is present in human milk, which resulted in infant doses of 0.16% to 0.7% of the maternal weight-adjusted dosage and a milk/plasma ratio ranging between 1.1 and 2.7. There are no reports of adverse effects on the breastfed infant and no effects on milk production. Long-term neurodevelopmental effects on infants from stimulant exposure are unknown. The developmental and health benefits of breastfeeding should be considered along with the mother's clinical need for Methylin and any potential adverse effects on the breastfed infant from Methylin or from the underlying maternal condition.

Clinical Considerations

Monitor breastfeeding infants for adverse reactions, such as agitation, insomnia, anorexia, and reduced weight gain.

8.4 Pediatric Use

The safety and effectiveness of Methylin for the treatment of ADHD have been established in pediatric patients six years of age and older. The safety and effectiveness of Methylin in pediatric patients under six years of age have not been established. The long-term efficacy of methylphenidate in pediatric patients has not been established.

Long-Term Suppression of Growth

Growth should be monitored during treatment with stimulants, including Methylin. Pediatric patients who are not growing or gaining weight as expected may need to have their treatment interrupted [*see Warnings and Precautions (5.6)*].

Juvenile Animal Toxicity Data

In a study conducted in young rats, methylphenidate was administered orally at doses of up to 100 mg/kg/day for 9 weeks, starting early in the postnatal period (postnatal Day 7) and continuing through sexual maturity (postnatal Week 10). When these animals were tested as adults (postnatal Weeks 13 -14), decreased spontaneous locomotor activity was observed in males and females previously treated with 50 mg/kg/day (approximately 4 times the MRHD of 60 mg/day given to children on a mg/m² basis) or greater, and a deficit in the acquisition of a specific learning task was seen in females exposed to the highest dose (8 times the MRHD given to children on a mg/m² basis). The no effect level for juvenile neurobehavioral development in rats (5 mg/kg/day) is less than the MRHD given to children on a mg/m² basis. The clinical significance of the long-term behavioral effects observed in rats is unknown.

8.5 Geriatric Use

Methylin has not been studied in the geriatric population.

9 DRUG ABUSE AND DEPENDENCE

9.1 Controlled Substance

Methylin contains methylphenidate hydrochloride, a Schedule II controlled substance.

9.2 Abuse

CNS stimulants, including Methylin, other methylphenidate-containing products, and amphetamines have a high potential for abuse. Abuse is the intentional non-therapeutic use of a drug, even once, to achieve a desired psychological or physiological effect. Drug addiction is a cluster of behavioral, cognitive, and physiological phenomena that may include a strong desire to take the drug, difficulties in controlling drug use (e.g., continuing drug use despite harmful consequences, giving a higher priority to drug use than other activities and obligations), and possible tolerance or physical dependence. Both abuse and misuse may lead to addiction, and some individuals may develop addiction even when taking Methylin as prescribed.

Signs and symptoms of CNS stimulant abuse include increased heart rate, respiratory rate, blood pressure, and/or sweating, dilated pupils, hyperactivity, restlessness, insomnia, decreased appetite, loss of coordination, tremors, flushed skin, vomiting, and/or abdominal pain. Anxiety, psychosis, hostility, aggression, and suicidal or homicidal ideation have also been observed. Individuals who abuse CNS stimulants may chew, snort, inject, or use other unapproved routes of administration which may result in overdose and death [see *Overdosage (10)*].

To reduce the abuse of Methylin, assess the risk of abuse prior to prescribing. After prescribing, keep careful prescription records, educate patients and their families about abuse and on proper storage and disposal of CNS stimulants [see *How Supplied/Storage and Handling (16)*], monitor for signs of abuse while on therapy, and re-evaluate the need for Methylin use.

9.3 Dependence

Physical Dependence

Methylin may produce physical dependence from continued therapy. Physical dependence is a state of adaptation manifested by a withdrawal syndrome produced by abrupt cessation, rapid dose reduction, or administration of an antagonist. Withdrawal symptoms after abrupt cessation following prolonged high-dosage administration of CNS stimulants include dysphoric mood; depression; fatigue; vivid, unpleasant dreams; insomnia or hypersomnia; increased appetite; and psychomotor retardation or agitation.

Tolerance

Methylin may produce tolerance from continued therapy. Tolerance is a state of adaptation in which exposure to a drug results in a reduction of the drug's desired and/or undesired effects over time).

10 OVERDOSAGE

Human Experience

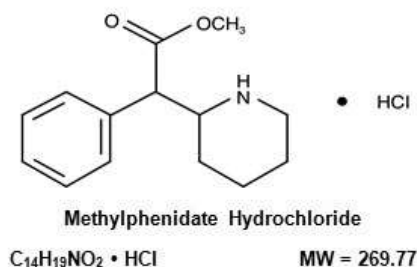
Signs and symptoms of acute methylphenidate overdose, resulting principally from overstimulation of the central nervous system and from excessive sympathomimetic effects, may include the following nausea, vomiting, diarrhea, restlessness, anxiety, agitation, tremors, hyperreflexia, muscle twitching, convulsions (which may be followed by coma), euphoria, confusion, hallucinations, delirium, sweating, flushing, headache, hyperpyrexia, tachycardia, palpitations, cardiac arrhythmias, hypertension, hypotension, tachypnea, mydriasis, dryness of mucous membranes, and rhabdomyolysis.

Overdose Management

Consult with a Certified Poison Control Center (1-800-222-1222) for the latest recommendations on the management of overdose with methylphenidate. Provide supportive care, including close medical supervision and monitoring. Treatment should consist of those general measures employed in the management of overdose with any drug. Consider the possibility of multiple drug overdose. Ensure an adequate airway, oxygenation, and ventilation. Monitor cardiac rhythm and vital signs. Use supportive and symptomatic measures.

11 DESCRIPTION

Methylin contains methylphenidate hydrochloride a CNS stimulant. It is available as an oral solution in 5 mg/5 mL and 10 mg/5 mL strengths for oral administration. Chemically, methylphenidate hydrochloride is (*d,l* (racemic) methyl α -phenyl-2-piperidineacetate hydrochloride and its structural formula is:



Methylphenidate hydrochloride is a white, odorless, fine crystalline powder. Its solutions are acid to litmus. It is freely soluble in water and in methanol, soluble in alcohol, and slightly soluble in chloroform and in acetone.

Each mL of Methylin 5 mg/5 mL contains 1 mg of methylphenidate hydrochloride USP.

Each mL of Methylin 10 mg/5 mL contains 2 mg of methylphenidate hydrochloride USP.

Methylin also contains the following inactive ingredients: citric acid anhydrous, glycerin, N&A grape flavor, PEG 1450, and purified water.

12 CLINICAL PHARMACOLOGY

12.1 Mechanism of Action

Methylphenidate hydrochloride is a central nervous system (CNS) stimulant. The mode of therapeutic action in ADHD is not known.

12.2 Pharmacodynamics

Methylphenidate is a racemic mixture comprised of the *d*- and *l*-threo enantiomers. The *d*-threo enantiomer is more pharmacologically active than the *l*-threo enantiomer. Methylphenidate blocks the reuptake of norepinephrine and dopamine into the presynaptic neuron and increases the release of these monoamines into the extraneuronal space.

Cardiac Electrophysiology

A formal QT study has not been conducted in subjects taking Methylin.

The effect of dexamethylphenidate, the pharmacologically active d-enantiomer of Methylin, on the QT interval was evaluated in a double-blind, placebo- and open-label active (moxifloxacin)-controlled study following single doses of 40 mg dexamethylphenidate hydrochloride extended-release capsule in 75 healthy volunteers. Electrocardiograms were collected up to 12 hours postdose. Frederica's method for heart rate correction was employed to derive the corrected QT interval (QTcF). The maximum mean prolongation of QTcF intervals was less than 5 ms, and the upper limit of the 90% confidence interval was below 10 ms for all time-matched comparisons versus placebo. This was below the threshold of clinical concern and there was no evident exposure response relationship.

12.3 Pharmacokinetics

Absorption

Following a single dose administration of 20 mg Methylin and 20 mg tablet of methylphenidate hydrochloride in healthy volunteers under fasted conditions, time to peak plasma concentration (T_{max}) of methylphenidate was at 1 to 2 hours after dosing, and:

- The mean peak plasma concentration (C_{max}) of methylphenidate was 9.1 ng/mL and 9.8 ng/mL, respectively.
- The mean area under concentration curve (AUC) of methylphenidate was 46.7 hour*ng/mL and 50.0 hour*ng/mL, respectively.

Effect of Food

Ingestion of a high-fat meal with Methylin increased methylphenidate mean C_{max} and AUC by about 13% and 25%, respectively. Time to C_{max} (T_{max}) was delayed by approximately 1 hour.

Distribution

Plasma protein binding is 10% to 33%. The volume of distribution was 2.65 ± 1.11 L/kg for d-methylphenidate and 1.80 ± 0.91 L/kg for l-methylphenidate.

Elimination

The mean terminal half-life ($t_{1/2}$) of methylphenidate was 2.7 hours following administration of 20 mg Methylin Oral Solution. The systemic clearance is 0.40 ± 0.12 L/h/kg for d-methylphenidate and 0.73 ± 0.28 L/h/kg for l-methylphenidate.

Metabolism

Methylphenidate is metabolized primarily by deesterification to alpha-phenyl-piperidine acetic acid (ritalinic acid), which has little or no pharmacologic activity.

Excretion

After oral dosing of radiolabeled methylphenidate in humans, about 90% of the radioactivity was recovered in urine. The main urinary metabolite was ritalinic acid, accounting for approximately 80% of the dose.

Specific Populations

Male and Female Patients, Racial Groups, and Age

The effect of gender, race, and age on the pharmacokinetics of methylphenidate after Methylin administration have not been studied.

Patients with Renal Impairment

Methylin has not been studied in patients with renal impairment. Since renal clearance is not an important route of methylphenidate clearance, renal impairment is expected to have little effect on the pharmacokinetics of Methylin.

Patients with Hepatic Impairment

Methylin has not been studied in patients with hepatic impairment. Since methylphenidate is metabolized primarily to ritalinic acid by nonmicrosomal hydrolytic esterases that are widely distributed throughout the body, hepatic impairment is expected to have minimal effect on the pharmacokinetics of Methylin.

13 NONCLINICAL TOXICOLOGY

13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility

Carcinogenesis

In a lifetime carcinogenicity study carried out in B6C3F1 mice, methylphenidate caused an increase in hepatocellular adenomas and, in males only, an increase in hepatoblastomas, at a daily dose of approximately 60 mg/kg/day. This dose is approximately 5 times the maximum recommended human dose (MRHD) of 60 mg/kg given to adults on a mg/m² basis. Hepatoblastoma is a relatively rare rodent malignant tumor type. There was no increase in total malignant hepatic tumors. The mouse strain used is sensitive to the development of hepatic tumors, and the significance of these results to humans is unknown.

Methylphenidate did not cause any increase in tumors in a lifetime carcinogenicity study carried out in F344 rats; the highest dose used was approximately 45 mg/kg/day, which is approximately 7 times the MRHD (adults) on a mg/m² basis.

In a 24-week carcinogenicity study in the transgenic mouse strain p53+/-, which is sensitive to genotoxic carcinogens, there was no evidence of carcinogenicity. Male and female mice were fed diets containing the same concentration of methylphenidate as in the lifetime carcinogenicity study; the high-dose groups were exposed to 60 to 74 mg/kg/day of methylphenidate.

Mutagenesis

Methylphenidate was not mutagenic in the *in vitro* Ames reverse mutation assay, in the *in vitro* mouse lymphoma cell forward mutation assay, or in the *in vitro* chromosomal aberration assay using human lymphocytes. Sister chromatid exchanges and chromosome aberrations were increased, indicative of a weak clastogenic response, in an *in vitro* assay in cultured Chinese Hamster Ovary (CHO) cells. Methylphenidate was negative *in vivo* in males and females in the mouse bone marrow micronucleus assay.

Impairment of Fertility

No human data on the effect of methylphenidate on fertility are available. Methylphenidate did not impair fertility in male or female mice that were fed diets containing the drug in an 18-week continuous breeding study. The study was conducted at doses up to 160 mg/kg/day, approximately 13 times the maximum recommended human dose of 60 mg/day given to adults on a mg/m² basis.

16 HOW SUPPLIED/STORAGE AND HANDLING

How Supplied

Methylin oral solution is a colorless, grape flavored liquid available in the following strengths:

- 5 mg per 5 mL
Bottles of 500 mL.....NDC 59630-750-50
- 10 mg per 5 mL
Bottles of 500 mL.....NDC 59630-755-50

Storage and Handling

Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature]. Dispense in tight container with child-resistant closure.

Disposal

Comply with local laws and regulations on drug disposal of CNS stimulants. Dispose of remaining, unused, or expired Methylin by a medicine take-back program or by an authorized collector registered with the Drug Enforcement Administration. If no take-back program or authorized collector is available, mix Methylin with an undesirable, nontoxic substance to make it less appealing to children and pets. Place the mixture in a container such as a sealed plastic bag and discard Methylin in the household trash.

17 PATIENT COUNSELING INFORMATION

Advise the patient to read the FDA-approved patient labeling (Medication Guide).

Controlled Substance Status/High Potential for Abuse and Dependence

Advise patients that Methylin is a federally controlled substance, and it can be abused and lead to dependence [see *Drug Abuse and Dependence (9.1, 9.2, and 9.3)*]. Instruct patients that they should not give Methylin to anyone else. Advise patients to store Methylin in a safe place, preferably locked, to prevent abuse. Advise patients to comply with laws and regulations on drug disposal. Advise patients to dispose of remaining, unused, or expired Methylin by a medicine take-back program if available [see *Warnings and Precautions (5.1)*, *Drug Abuse and Dependence (9)*, *How Supplied/Storage and Handling (16)*].

Serious Cardiovascular Risks

Advise patients that there is a potential serious cardiovascular risk including sudden death, myocardial infarction, and stroke with Methylin. Instruct patients to contact a healthcare provider immediately if they develop symptoms such as exertional chest pain, unexplained syncope, or other symptoms suggestive of cardiac disease [see *Warnings and Precautions (5.2)*].

Blood Pressure and Heart Rate Increases

Instruct patients that Methylin can elevate blood pressure and heart rate [see *Warnings and Precautions (5.3)*].

Psychiatric Risks

Advise patients that Methylin, at recommended doses, can cause psychotic or manic symptoms, even in patients without prior history of psychotic symptoms or mania [see *Warnings and Precautions (5.4)*].

Priapism

Advise patients of the possibility of painful or prolonged penile erections (priapism). Instruct the patient to seek immediate medical attention in the event of priapism [see *Warnings and Precautions (5.5)*].

Circulation Problems in Fingers and Toes (Peripheral Vasculopathy, Including Raynaud's Phenomenon)

Instruct patients about the risk of peripheral vasculopathy, including Raynaud's phenomenon, and associated signs and symptoms: fingers or toes may feel numb, cool, painful, and/or may change color from pale, to blue, to red.

Instruct patients to report to their physician any new numbness, pain, skin color change, or sensitivity to temperature in fingers or toes. Instruct patients to call their physician immediately with any signs of unexplained wounds appearing on fingers or toes while taking Methylin. Further clinical evaluation (e.g., rheumatology referral) may be appropriate for certain patients [see *Warnings and Precautions (5.6)*].

Suppression of Growth

Advise patients that Methylin may cause slowing of growth and weight loss in pediatric patients [see *Warnings and Precautions (5.7)*].

Pregnancy Exposure Registry

Inform patients that there is a pregnancy exposure registry that monitors pregnancy outcomes in patients exposed to Methylin during pregnancy [see *Use in Specific Populations (8.1)*].

Distributed by:

Shionogi Inc.

Florham Park, NJ 07932

Manufactured by:

SpecGx LLC

Webster Groves, MO 63119 USA

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MOS-PI-08

L20M21

An electronic copy of this medication guide can be obtained from www.mallinckrodt.com/Medguide/L20M31.pdf or by calling 1-800-778-7898 for alternate delivery options.

MEDICATION GUIDE

MEDICATION GUIDE

METHYLIN® (METH il in)

(methylphenidate hydrochloride)

oral solution, CII

What is the most important information I should know about METHYLIN?

METHYLIN can cause serious side effects, including:

- **Abuse and dependence.** METHYLIN, other methylphenidate containing medicines, and amphetamines have a high chance for abuse and can cause physical and psychological dependence. Your healthcare provider should check you or your child for signs of abuse and dependence before and during treatment with METHYLIN.
 - Tell your healthcare provider if you or your child have ever abused or been dependent on alcohol, prescription medicines, or street drugs.
 - Your healthcare provider can tell you more about the differences between physical and psychological dependence and drug addiction.
- **Heart-related problems, including:**
 - sudden death, stroke, and heart attack in adults
 - sudden death in children who have heart problems or heart defects
 - increased blood pressure and heart rate

Your healthcare provider should check you or your child carefully for heart problems before starting treatment with METHYLIN. Tell your healthcare provider if you or your child have any heart problems, heart defects, high blood pressure, or have a family history of these problems.

Your healthcare provider should check your or your child's blood pressure and heart rate regularly during treatment with METHYLIN.

Call your healthcare provider or go to the nearest hospital emergency room right away if you or your child have any signs of heart problems such as chest pain, shortness of breath, or fainting during treatment with METHYLIN.

• **Mental (psychiatric) problems, including:**

- new or worse behavior and thought problems
- new or worse bipolar illness
- new psychotic symptoms (such as hearing voices, or seeing or believing things that are not real) or new manic symptoms

Tell your healthcare provider about any mental problems you or your child have, or about a family history of suicide, bipolar illness, or depression.

Call your healthcare provider right away if you or your child have any new or worsening mental symptoms or problems during treatment with METHYLIN, especially hearing voices, seeing or believing things that are not real, or new manic symptoms.

What is METHYLIN?

METHYLIN is a prescription medicine used for the treatment of Attention Deficit Hyperactivity Disorder (ADHD) in people 6 years of age and older. METHYLIN may help increase attention and decrease impulsiveness and hyperactivity in people with ADHD.

It is not known if METHYLIN is safe and effective for use in children under 6 years of age.

METHYLIN is a federally controlled substance (CII) because it contains methylphenidate that can be a target for people who abuse prescription medicines or street drugs. Keep METHYLIN in a safe place to protect it from theft. Never give your METHYLIN to anyone else, because it may cause death or harm them. Selling or giving away METHYLIN may harm others and is against the law.

Do not take METHYLIN if you or your child are:

- allergic to methylphenidate hydrochloride or any of the ingredients in METHYLIN. See the end of this Medication Guide for a complete list of ingredients in METHYLIN.
- taking, or have stopped taking within the past 14 days, a medicine called a monoamine oxidase inhibitor (MAOI).

Before taking METHYLIN tell your healthcare provider about all your medical conditions, including if you or your child:

- have heart problems, heart defects, or high blood pressure
- have mental problems including psychosis, mania, bipolar illness, or depression, or have a family history of suicide, bipolar illness, or depression
- have circulation problems in fingers and toes
- are pregnant or plan to become pregnant. It is not known if METHYLIN will harm the unborn baby.
 - There is a pregnancy registry for females who are exposed to METHYLIN during pregnancy. The purpose of the registry is to collect information about the health of females exposed to METHYLIN and their baby. If you or your child becomes pregnant during treatment with METHYLIN, talk to your healthcare provider about registering with the National Pregnancy Registry for Psychostimulants at 1-866-961-2388.
- are breastfeeding or plan to breastfeed. METHYLIN passes into breast milk. Talk to your healthcare provider about the best way to feed the baby during treatment with METHYLIN.

Tell your healthcare provider about all the medicines that you take or your child take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

METHYLIN and some medicines may interact with each other and cause serious side effects. Sometimes the doses of other medicines will need to be changed during treatment with METHYLIN. Your healthcare provider will decide whether METHYLIN can be taken with other medicines. **Especially tell your healthcare provider if you or your child take** a medicine used to treat depression called a monoamine oxidase inhibitor (MAOI).

Know the medicines that you take or your child take. Keep a list of your medicines with you to show your healthcare provider and pharmacist. **Do not start any new medicine during treatment with METHYLIN without talking to your healthcare provider first.**

How should METHYLIN be taken?

- Take METHYLIN exactly as prescribed by your healthcare provider.
- Your healthcare provider may change the dose if needed.
- **Children 6 years of age and older:**
 - Take METHYLIN by mouth 2 times a day before breakfast and lunch, 30 to 45 before a meal, as prescribed by your healthcare provider.
- **Adults:**
 - Take METHYLIN by mouth 2 or 3 times a day, 30 to 45 before a meal, as prescribed by your healthcare provider.
 - For adults who have sleep problems when METHYLIN is taken late in the day, take your last dose of METHYLIN before 6 p.m.
- Your healthcare provider may sometimes stop METHYLIN treatment for a while to check ADHD symptoms.
- If you or your child take too much METHYLIN, call your poison control center at 1-800-222-1222 or go to the nearest hospital emergency room right away.

What are the possible side effects of METHYLIN?

METHYLIN can cause serious side effects, including:

- See “**What is the most important information I should know about METHYLIN?**”
- **Painful and prolonged erections (priapism).** Priapism has happened in males who take products that contain methylphenidate. **If you or your child develop priapism, get medical help right away.**
- **Circulation problems in fingers and toes (peripheral vasculopathy, including Raynaud’s phenomenon).**
Signs and symptoms may include:
 - fingers or toes may feel numb, cool, painful
 - fingers or toes may change color from pale, to blue, to red

Tell your healthcare provider if you or your child have numbness, pain, skin color change, or sensitivity to temperature in the fingers or toes, or if you or your child have any signs of unexplained wounds appearing on fingers or toes during treatment with METHYLIN.

- **Slowing of growth (height and weight) in children.** Children should have their height and weight checked often during treatment with METHYLIN. METHYLIN treatment may be stopped if your child is not growing or gaining weight.

The most common side effects of METHYLIN include:

- increased heart rate
- headache
- anxiety
- weight loss
- dry mouth
- stomach pain
- irregular heart beat (palpitations)
- trouble sleeping
- sweating
- decreased appetite
- nausea

These are not all the possible side effects of METHYLIN.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store METHYLIN?

- Store METHYLIN at room temperature between 68°F to 77°F (20°C to 25°C).
Store METHYLIN in a safe place, like a locked cabinet.
- Protect from light and moisture.
- Dispose of remaining, unused, or expired METHYLIN by a medication take-back program at authorized collection sites such as retail pharmacies, hospital or clinic pharmacies, and law enforcement locations. If no take-back program or authorized collector is available, mix METHYLIN with an undesirable, nontoxic substance such as dirt, cat litter, or used coffee grounds to make it less appealing to children and pets. Place the mixture in a container such as a sealed plastic bag and throw away METHYLIN in the household trash.

Keep METHYLIN and all medicines out of the reach of children.

General information about the safe and effective use of METHYLIN.

Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. Do not use METHYLIN for a condition for which it was not prescribed. Do not give METHYLIN to other people, even if they have the same symptoms. It may harm them and it is against the law. You can ask your healthcare provider or pharmacist for information about METHYLIN that was written for healthcare professionals.

What are the ingredients in METHYLIN?

Active Ingredient: methylphenidate hydrochloride USP

Inactive Ingredients: citric acid anhydrous, glycerin, N&A grape flavor, PEG 1450, and purified water

Distributed by: Shionogi Inc., Florham Park, NJ 07932

Manufactured by: SpecGx LLC, Webster Groves, MO 63119 USA
For more information go to www.methylinrx.com or call 1-800-849-9707.

This Medication Guide has been approved by the U.S. Food and Drug Administration.

Revised: 07/2021

MOS-MG-06

L20M31

PRINCIPAL DISPLAY PANEL - 5 mg per 5 mL

NDC 59630-750-50

500 mL

CII

Methylin® Oral Solution
methylphenidate HCl oral solution

5 mg per 5 mL

Rx only

PHARMACIST: Dispense the Medication Guide provided separately to each patient.

SHIONOGI INC.

L00M63

Rev 10/2018

NDC 59630-750-50
500 mL

CII

Methylin®
Oral Solution
methylphenidate
HCl oral solution

5 mg per 5 mL

Rx only

PHARMACIST: Dispense the Medication Guide provided separately to each patient.

SHIONOGI INC.

USUAL DOSAGE:
See package insert.

Each milliliter contains:
Methylphenidate
Hydrochloride USP 1 mg

STORAGE: Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].

Dispense in tight container with child-resistant closure.

Do not accept if seal over bottle opening is broken or missing.

Distributed by:
Shionogi Inc.
Florham Park, NJ 07932

Manufactured by:
SpecGx LLC
Webster Groves, MO 63119 USA

Lot: 0000000000
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GTIN: 0039630750503
L00M63 Rev 10/2018

PRINCIPAL DISPLAY PANEL - 10 mg per 5 mL

NDC 59630-755-50

500 mL

CII

Methylin® Oral Solution
methylphenidate HCl oral solution

10 mg per 5 mL

Rx only

PHARMACIST: Dispense the Medication Guide provided separately to each patient.

SHIONOGI INC.

L00M62

Rev 10/2018

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Exp: 000000
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GTIN: 0239630755508
L00M62 Rev 10/2018

NDC 59630-755-50
500 mL

C II

Methylin®
Oral Solution
methylphenidate
HCl oral solution

10 mg per 5 mL

Rx only

PHARMACIST: Dispense the
Medication Guide provided
separately to each patient.

 **SHIONOGI INC.**

USUAL DOSAGE:
See package insert.

Each milliliter contains:
Methylphenidate
Hydrochloride USP: 2 mg

STORAGE: Store at 20° to
25°C (68° to 77°F) [see USP
Controlled Room Temperature].

Dispense in tight container with
child-resistant closure.

Do not accept if seal over
bottle opening is broken
or missing.

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Florham Park, NJ 07932

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