

## HIGHLIGHTS OF PRESCRIBING INFORMATION

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

PRINIVIL® (lisinopril) tablets, for oral use  
Initial U.S. Approval: 1987

### WARNING: FETAL TOXICITY

See full prescribing information for complete boxed warning.

- When pregnancy is detected, discontinue PRINIVIL as soon as possible (5.1).
- Drugs that act directly on the renin-angiotensin system can cause injury and death to the developing fetus (5.1).

### INDICATIONS AND USAGE

PRINIVIL is an angiotensin converting enzyme (ACE) inhibitor indicated for:

- Treatment of hypertension in adults and pediatric patients ≥6 years of age (1.1)
- Adjunctive therapy for heart failure (1.2)
- Treatment of acute myocardial infarction (1.3)

### DOSAGE AND ADMINISTRATION

- Hypertension: Initiate adults at 10 mg (monotherapy) or 5 mg (on a diuretic) once daily. Titrate up to 40 mg daily based on response. Initial dose in patients 6 years of age and older is 0.07 mg/kg (up to 5 mg total) once daily (2.1)
- Heart Failure: Initiate with 5 mg once daily. Increase dose as tolerated to 40 mg daily (2.2)
- Acute Myocardial Infarction (MI): Give 5 mg within 24 hours of MI followed by 5 mg after 24 hours, then 10 mg once daily (2.3)
- Renal Impairment: For patients with creatinine clearance 10-30 mL/min, halve the usual initial dose. For creatinine clearance <10 mL/min or on hemodialysis, initiate at 2.5 mg (2.4)

### DOSAGE FORMS AND STRENGTHS

- Tablets (lisinopril content): 5 mg; 10 mg; and 20 mg (3)

### CONTRAINDICATIONS

- Angioedema or a history of hereditary or idiopathic angioedema (4)
- Hypersensitivity (4)

- Coadministration of aliskiren with PRINIVIL in patients with diabetes (4, 7.4)
- PRINIVIL is contraindicated in combination with a neprilysin inhibitor (e.g., sacubitril). Do not administer PRINIVIL within 36 hours of switching to or from sacubitril/valsartan, a product containing a neprilysin inhibitor (4)

### WARNINGS AND PRECAUTIONS

- Angioedema: Discontinue PRINIVIL (5.2)
- Renal impairment: Monitor renal function periodically (5.3)
- Hypotension: Monitor blood pressure after initiation (5.4)
- Hyperkalemia: Monitor serum potassium periodically (5.5)
- Cholestatic jaundice and hepatic failure: Discontinue PRINIVIL (5.6)

### ADVERSE REACTIONS

Common adverse reactions (events 2% greater than on placebo):

- Hypertension: headache, dizziness and cough (6.1)
- Heart Failure: hypotension and chest pain (6.1)
- Acute Myocardial Infarction: hypotension (6.1)

To report SUSPECTED ADVERSE REACTIONS, contact Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., at 1-877-888-4231 or FDA at 1-800-FDA-1088 or [www.fda.gov/medwatch](http://www.fda.gov/medwatch).

### DRUG INTERACTIONS

- Diuretics: Excessive drop in blood pressure (7.1)
- NSAIDs: Increased risk of renal impairment and loss of antihypertensive efficacy (7.3)
- Dual inhibition of the renin-angiotensin system: Increased risk of renal impairment, hypotension, syncope, and hyperkalemia (7.4)
- Lithium: Symptoms of lithium toxicity (7.5)
- Gold: Nitritoid reactions (7.6)

### USE IN SPECIFIC POPULATIONS

- Pregnancy: Discontinue PRINIVIL if pregnancy is detected (5.1, 8.1)
- Pediatrics: Safety and effectiveness have not been established in patients <6 years of age or with glomerular filtration rate <30 mL/min/1.73 m<sup>2</sup> (8.4)
- Race: Less antihypertensive effect in Blacks than non-Blacks (8.6)

See 17 for PATIENT COUNSELING INFORMATION.

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## FULL PRESCRIBING INFORMATION

### WARNING: FETAL TOXICITY

**When pregnancy is detected, discontinue PRINIVIL as soon as possible [see Warnings and Precautions (5.1)].**

**Drugs that act directly on the renin-angiotensin system can cause injury and death to the developing fetus [see Warnings and Precautions (5.1)].**

## 1 INDICATIONS AND USAGE

### 1.1 Hypertension

PRINIVIL is indicated for the treatment of hypertension in adult patients and pediatric patients 6 years of age and older to lower blood pressure. Lowering blood pressure lowers the risk of fatal and non-fatal cardiovascular events, primarily strokes and myocardial infarctions. These benefits have been seen in controlled trials of antihypertensive drugs from a wide variety of pharmacologic classes.

Control of high blood pressure should be part of comprehensive cardiovascular risk management, including, as appropriate, lipid control, diabetes management, antithrombotic therapy, smoking cessation, exercise, and limited sodium intake. Many patients will require more than 1 drug to achieve blood pressure goals. For specific advice on goals and management, see published guidelines, such as those of the National High Blood Pressure Education Program's Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC).

Numerous antihypertensive drugs, from a variety of pharmacologic classes and with different mechanisms of action, have been shown in randomized controlled trials to reduce cardiovascular morbidity and mortality, and it can be concluded that it is blood pressure reduction, and not some other pharmacologic property of the drugs, that is largely responsible for those benefits. The largest and most consistent cardiovascular outcome benefit has been a reduction in the risk of stroke, but reductions in myocardial infarction and cardiovascular mortality also have been seen regularly.

Elevated systolic or diastolic pressure causes increased cardiovascular risk, and the absolute risk increase per mmHg is greater at higher blood pressures, so that even modest reductions of severe hypertension can provide substantial benefit. Relative risk reduction from blood pressure reduction is similar across populations with varying absolute risk, so the absolute benefit is greater in patients who are at higher risk independent of their hypertension (for example, patients with diabetes or hyperlipidemia), and such patients would be expected to benefit from more aggressive treatment to a lower blood pressure goal.

Some antihypertensive drugs have smaller blood pressure effects (as monotherapy) in Black patients, and many antihypertensive drugs have additional approved indications and effects (e.g., on angina, heart failure, or diabetic kidney disease). These considerations may guide selection of therapy.

PRINIVIL may be administered alone or with other antihypertensive agents [see *Clinical Studies* (14.1)].

### 1.2 Heart Failure

PRINIVIL is indicated to reduce signs and symptoms of heart failure in patients who are not responding adequately to diuretics and digitalis [see *Clinical Studies* (14.2)].

### 1.3 Acute Myocardial Infarction

PRINIVIL is indicated for the reduction of mortality in treatment of hemodynamically stable patients within 24 hours of acute myocardial infarction. Patients should receive, as appropriate, the standard recommended treatments such as thrombolytics, aspirin and beta-blockers [see *Clinical Studies* (14.3)].

## **2 DOSAGE AND ADMINISTRATION**

### **2.1 Hypertension**

Initial therapy in adults: The recommended initial dose is 10 mg once a day. Adjust dosage according to blood pressure response. The usual dosage range is 20 to 40 mg per day administered in a single daily dose. Doses up to 80 mg have been used but do not appear to give a greater effect.

#### *Use with Diuretics in Adults*

If blood pressure is not controlled with PRINIVIL alone, a low dose of a diuretic may be added (e.g., hydrochlorothiazide 12.5 mg).

The recommended starting dose in adult patients with hypertension taking diuretics is 5 mg once per day [see *Drug Interactions* (7.1)].

#### *Pediatric Patients 6 Years of Age and Older with Hypertension*

For pediatric patients with glomerular filtration rate  $>30$  mL/min/ $1.73$  m<sup>2</sup>, the recommended starting dose is 0.07 mg/kg once daily (up to 5 mg total). Dosage should be adjusted according to blood pressure response up to a maximum of 0.61 mg/kg (up to 40 mg) once daily. Doses above 0.61 mg/kg (or in excess of 40 mg) have not been studied in pediatric patients [see *Clinical Pharmacology* (12.3)].

PRINIVIL is not recommended in pediatric patients  $<6$  years or in pediatric patients with glomerular filtration rate  $<30$  mL/min/ $1.73$  m<sup>2</sup> [see *Use in Specific Populations* (8.4) and *Clinical Studies* (14.1)].

### **2.2 Heart Failure**

The recommended starting dose for PRINIVIL, when used with diuretics and (usually) digitalis as adjunctive therapy is 5 mg once daily. The recommended starting dose in these patients with hyponatremia (serum sodium  $<130$  mEq/L) is 2.5 mg once daily. Increase as tolerated to a maximum of 40 mg once daily.

Diuretic dose may need to be adjusted to help minimize hypovolemia, which may contribute to hypotension [see *Warnings and Precautions* (5.4) and *Drug Interactions* (7.1)]. The appearance of hypotension after the initial dose of PRINIVIL does not preclude subsequent careful dose titration with the drug, following effective management of the hypotension.

### **2.3 Acute Myocardial Infarction**

In hemodynamically stable patients within 24 hours of the onset of symptoms of acute myocardial infarction, give PRINIVIL 5 mg orally, followed by 5 mg after 24 hours, 10 mg after 48 hours and then 10 mg once daily. Dosing should continue for at least 6 weeks.

Initiate therapy with 2.5 mg in patients with a low systolic blood pressure (100-120 mmHg) during the first 3 days after the infarct [see *Warnings and Precautions* (5.4)]. If hypotension occurs (systolic blood pressure  $\leq 100$  mmHg) consider doses of 2.5 or 5 mg. If prolonged hypotension occurs (systolic blood pressure  $<90$  mmHg for more than 1 hour) discontinue PRINIVIL.

### **2.4 Dose in Patients with Renal Impairment**

No dose adjustment of PRINIVIL is required in patients with creatinine clearance  $>30$  mL/min. In patients with creatinine clearance 10-30 mL/min, reduce the initial dose of PRINIVIL to half of the usual recommended dose (i.e., hypertension, 5 mg; heart failure or acute MI, 2.5 mg). For patients on hemodialysis or creatinine clearance  $<10$  mL/min, the recommended initial dose is 2.5 mg once daily [see *Use in Specific Populations* (8.7) and *Clinical Pharmacology* (12.3)].

### **2.5 Preparation of Suspension**

To make 200 mL of a suspension at 1.0 mg/mL, add 10 mL of Purified Water USP to a polyethylene terephthalate (PET) bottle containing ten 20-mg tablets of PRINIVIL and shake for at least one minute.

Add 30 mL of Sodium Citrate and Citric Acid Oral Solution or Cytra-2 diluent and 160 mL of Ora-Sweet SF™ to the concentrate in the PET bottle and gently shake for several seconds to disperse the ingredients. The suspension should be stored at or below 25°C (77°F) and can be stored for up to four weeks. Shake the suspension before each use.

### 3 DOSAGE FORMS AND STRENGTHS

Tablets PRINIVIL, 5 mg, are white, oval-shaped compressed tablets with code MSD 19 on one side and scored on the other side.

Tablets PRINIVIL, 10 mg, are light yellow, oval-shaped compressed tablets with code MSD 106 on one side and scored on the other side.

Tablets PRINIVIL, 20 mg, are peach, oval-shaped compressed tablets with code MSD 207 on one side and scored on the other side.

### 4 CONTRAINDICATIONS

PRINIVIL is contraindicated in patients with:

- a history of angioedema or hypersensitivity related to previous treatment with an angiotensin converting enzyme inhibitor
- hereditary or idiopathic angioedema.

Do not coadminister aliskiren with PRINIVIL in patients with diabetes [see *Drug Interactions* (7.4)].

PRINIVIL is contraindicated in combination with a neprilysin inhibitor (e.g., sacubitril). Do not administer PRINIVIL within 36 hours of switching to or from sacubitril/valsartan, a product containing a neprilysin inhibitor [see *Warnings and Precautions* (5.2) and *Drug Interactions* (7.8)].

### 5 WARNINGS AND PRECAUTIONS

#### 5.1 Fetal Toxicity

##### *Pregnancy Category D*

Use of drugs that act on the renin-angiotensin system during the second and third trimesters of pregnancy reduces fetal renal function and increases fetal and neonatal morbidity and death. Resulting oligohydramnios can be associated with fetal lung hypoplasia and skeletal deformations. Potential neonatal adverse effects include skull hypoplasia, anuria, hypotension, renal failure, and death. When pregnancy is detected, discontinue PRINIVIL as soon as possible [see *Use in Specific Populations* (8.1)].

#### 5.2 Angioedema and Anaphylactoid Reactions

##### *Angioedema*

##### *Head and Neck Angioedema:*

Angioedema of the face, extremities, lips, tongue, glottis and/or larynx, including some fatal reactions, have occurred in patients treated with angiotensin converting enzyme inhibitors, including PRINIVIL, at any time during treatment. Patients with involvement of the tongue, glottis or larynx are likely to experience airway obstruction, especially those with a history of airway surgery. PRINIVIL should be promptly discontinued and appropriate therapy and monitoring should be provided until complete and sustained resolution of signs and symptoms of angioedema has occurred.

Patients with a history of angioedema unrelated to ACE inhibitor therapy may be at increased risk of angioedema while receiving an ACE inhibitor [see *Contraindications* (4)]. ACE inhibitors have been associated with a higher rate of angioedema in Black than in non-Black patients.

Patients receiving concomitant ACE inhibitor and mTOR (mammalian target of rapamycin) inhibitor (e.g., temsirolimus, sirolimus, everolimus) therapy may be at increased risk for angioedema [see *Drug Interactions* (7.7)].

Patients receiving concomitant ACE inhibitor and neprilysin inhibitor therapy may be at increased risk for angioedema [see *Contraindications (4) and Drug Interactions (7.8)*].

**Intestinal Angioedema:**

Intestinal angioedema has occurred in patients treated with ACE inhibitors. These patients presented with abdominal pain (with or without nausea or vomiting); in some cases there was no prior history of facial angioedema and C-1 esterase levels were normal. In some cases, the angioedema was diagnosed by procedures including abdominal CT scan or ultrasound, or at surgery, and symptoms resolved after stopping the ACE inhibitor.

**Anaphylactoid Reactions**

**Anaphylactoid Reactions During Desensitization:**

Two patients undergoing desensitizing treatment with Hymenoptera venom while receiving ACE inhibitors sustained life-threatening anaphylactoid reactions.

**Anaphylactoid Reactions During Dialysis:**

Sudden and potentially life-threatening anaphylactoid reactions have occurred in some patients dialyzed with high-flux membranes and treated concomitantly with an ACE inhibitor. In such patients, dialysis must be stopped immediately, and aggressive therapy for anaphylactoid reactions must be initiated. Symptoms have not been relieved by antihistamines in these situations. In these patients, consideration should be given to using a different type of dialysis membrane or a different class of antihypertensive agent. Anaphylactoid reactions have also been reported in patients undergoing low-density lipoprotein apheresis with dextran sulfate absorption.

### **5.3 Impaired Renal Function**

Monitor renal function periodically in patients treated with PRINIVIL. Changes in renal function including acute renal failure can be caused by drugs that inhibit the renin-angiotensin system. Patients whose renal function may depend in part on the activity of the renin-angiotensin system (e.g., patients with renal artery stenosis, chronic kidney disease, severe congestive heart failure, post-myocardial infarction or volume depletion) may be at particular risk of developing acute renal failure on PRINIVIL. Consider withholding or discontinuing therapy in patients who develop a clinically significant decrease in renal function on PRINIVIL [see *Adverse Reactions (6.1) and Drug Interactions (7.4)*].

### **5.4 Hypotension**

PRINIVIL can cause symptomatic hypotension, sometimes complicated by oliguria, progressive azotemia, acute renal failure or death. Patients at risk of excessive hypotension include those with the following conditions or characteristics: heart failure with systolic blood pressure below 100 mmHg, ischemic heart disease, cerebrovascular disease, hyponatremia, high dose diuretic therapy, renal dialysis, or severe volume and/or salt depletion of any etiology.

In these patients, start PRINIVIL under medical supervision and follow such patients for the first two weeks of treatment and whenever the dose of PRINIVIL and/or diuretic is increased. Avoid use of PRINIVIL in patients who are hemodynamically unstable after acute MI.

Symptomatic hypotension is also possible in patients with severe aortic stenosis or hypertrophic cardiomyopathy.

*Surgery/Anesthesia:* In patients undergoing major surgery or during anesthesia with agents that produce hypotension, PRINIVIL may block angiotensin II formation secondary to compensatory renin release. If hypotension occurs and is considered to be due to this mechanism, it can be corrected by volume expansion.

### **5.5 Hyperkalemia**

Monitor serum potassium periodically in patients receiving PRINIVIL. Drugs that inhibit the renin-angiotensin system can cause hyperkalemia. Risk factors for the development of hyperkalemia include renal insufficiency, diabetes mellitus, and the concomitant use of potassium-sparing diuretics, potassium

supplements, potassium-containing salt substitutes, or other drugs that may increase serum potassium [see *Drug Interactions* (7.1)].

## 5.6 Hepatic Failure

ACE inhibitors have been associated with a syndrome that starts with cholestatic jaundice or hepatitis and progresses to fulminant hepatic necrosis and sometimes death. The mechanism of this syndrome is not understood. Patients receiving ACE inhibitors who develop jaundice or marked elevations of hepatic enzymes should discontinue the ACE inhibitor and receive appropriate medical treatment.

# 6 ADVERSE REACTIONS

## 6.1 Clinical Trials Experience

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical studies of a drug cannot be directly compared to rates in the clinical studies of another drug and may not reflect the rates observed in practice.

### Hypertension

The following adverse reactions (events 2% greater on PRINIVIL than on placebo) were observed with PRINIVIL vs placebo: headache (5.7% vs 1.9%), dizziness (5.4% vs 1.9%), cough (3.5% vs 1.0%).

### Heart Failure

In controlled studies in patients with heart failure, therapy was discontinued in 8.1% of patients treated with PRINIVIL for 12 weeks, compared to 7.7% of patients treated with placebo for 12 weeks.

The following adverse reactions (events 2% greater on PRINIVIL than on placebo) were observed with PRINIVIL vs placebo: hypotension (4.4% vs 0.6%), chest pain (3.4% vs 1.3%).

In the ATLAS trial [see *Clinical Studies* (14.2)] in heart failure patients, withdrawals for adverse reactions were similar in the low- and high-dose groups. The following adverse reactions, mostly related to ACE inhibition, were reported more commonly in the high dose group:

Table 1: Dose-related Adverse Drug Reactions: ATLAS trial

|                      | High Dose<br>(n=1568) | Low Dose<br>(n=1596) |
|----------------------|-----------------------|----------------------|
| Dizziness            | 19%                   | 12%                  |
| Hypotension          | 11%                   | 7%                   |
| Creatinine increased | 10%                   | 7%                   |
| Hyperkalemia         | 6%                    | 4%                   |
| Syncope              | 7%                    | 5%                   |

### Acute Myocardial Infarction

Patients in the GISSI-3 study, treated with PRINIVIL, had a higher incidence of hypotension (9.0% vs 3.7%) and renal dysfunction (2.4% vs 1.1%) compared with patients not taking PRINIVIL.

Other clinical adverse reactions occurring in 1% or higher of patients with hypertension or heart failure treated with PRINIVIL in controlled clinical trials and do not appear in other sections of labeling are listed below:

Body as a whole: Fatigue, asthenia, orthostatic effects.

Digestive: Pancreatitis, constipation, flatulence, dry mouth, diarrhea.

Hematologic: Rare cases of bone marrow depression, hemolytic anemia, leukopenia/neutropenia and thrombocytopenia.

Endocrine: Diabetes mellitus, inappropriate antidiuretic hormone secretion.

Metabolic: Gout

Skin: Urticaria, alopecia, photosensitivity, erythema, flushing, diaphoresis, cutaneous pseudolymphoma, toxic epidermal necrolysis, Stevens – Johnson syndrome, and pruritus.

Special Senses: Visual loss, diplopia, blurred vision, tinnitus, photophobia, taste disturbances, olfactory disturbances.

Urogenital: Impotence

Miscellaneous: A symptom complex has been reported which may include a positive ANA, an elevated erythrocyte sedimentation rate, arthralgia/arthritis, myalgia, fever, vasculitis, eosinophilia, leukocytosis, paresthesia and vertigo. Rash, photosensitivity or other dermatological manifestations may occur alone or in combination with these symptoms.

#### *Clinical Laboratory Test Findings*

*Serum Potassium:* In clinical trials hyperkalemia (serum potassium >5.7 mEq/L) occurred in 2.2% and 4.8% of PRINIVIL-treated patients with hypertension and heart failure, respectively [see *Warnings and Precautions* (5.5)].

**Creatinine, Blood Urea Nitrogen:** Minor increases in blood urea nitrogen and serum creatinine, reversible upon discontinuation of therapy, were observed in about 2% of patients with hypertension treated with PRINIVIL alone. Increases were more common in patients receiving concomitant diuretics and in patients with renal artery stenosis [see *Warnings and Precautions* (5.4)]. Reversible minor increases in blood urea nitrogen and serum creatinine were observed in 11.6% of patients with heart failure on concomitant diuretic therapy. Frequently, these abnormalities resolved when the dosage of the diuretic was decreased.

Patients with acute myocardial infarction in the GISSI-3 trial treated with PRINIVIL had a higher (2.4% versus 1.1% in placebo) incidence of renal dysfunction in-hospital and at 6 weeks (increasing creatinine concentration to over 3 mg/dL or a doubling or more of the baseline serum creatinine concentration).

**Hemoglobin and Hematocrit:** Small decreases in hemoglobin (mean 0.4 mg/dL) and hematocrit (mean 1.3%) occurred frequently in patients treated with PRINIVIL but were rarely of clinical importance in patients without some other cause of anemia. In clinical trials, fewer than 0.1% of patients discontinued therapy for anemia.

#### *Liver Enzymes*

Rarely, elevations of liver enzymes and/or serum bilirubin have occurred [see *Warnings and Precautions* (5.6)].

## **6.2 Postmarketing Experience**

The following adverse reactions have been identified during post-approval use of lisinopril that are not included in other sections of labeling. Because these reactions are 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.

Other reactions include:

*Metabolism and nutrition disorders*

Hyponatremia [see *Warnings and Precautions* (5.4)], cases of hypoglycemia in diabetic patients on oral antidiabetic agents or insulin [see *Drug Interactions* (7.2)]

*Nervous system and psychiatric disorders*

Mood alterations (including depressive symptoms), mental confusion

## **7 DRUG INTERACTIONS**

### **7.1 Diuretics**

Initiation of PRINIVIL in patients on diuretics may result in excessive reduction of blood pressure. The possibility of hypotensive effects with PRINIVIL can be minimized by either decreasing or discontinuing the diuretic or increasing the salt intake prior to initiation of treatment with PRINIVIL. If this is not possible, reduce the starting dose of PRINIVIL [see *Dosage and Administration* (2.2) and *Warnings and Precautions* (5.4)].

PRINIVIL attenuates potassium loss caused by thiazide-type diuretics. Potassium-sparing diuretics (spironolactone, amiloride, triamterene, and others) or other drugs that may increase serum potassium can increase the risk of hyperkalemia. Therefore, if concomitant use of such agents is indicated, monitor the patient's serum potassium frequently.

### **7.2 Antidiabetics**

Concomitant administration of PRINIVIL and antidiabetic medicines (insulins, oral hypoglycemic agents) may cause an increased blood-glucose-lowering effect with risk of hypoglycemia.

### **7.3 Non-Steroidal Anti-Inflammatory Agents Including Selective Cyclooxygenase-2 Inhibitors (COX-2 Inhibitors)**

In patients who are elderly, volume-depleted (including those on diuretic therapy), or with compromised renal function, coadministration of NSAIDs, including selective COX-2 inhibitors, with ACE inhibitors, including lisinopril, may result in deterioration of renal function, including possible acute renal failure. These effects are usually reversible. Monitor renal function periodically in patients receiving lisinopril and NSAID therapy.

The antihypertensive effect of ACE inhibitors, including lisinopril, may be attenuated by NSAIDs.

### **7.4 Dual Blockade of the Renin-Angiotensin System (RAS)**

Dual blockade of the RAS with angiotensin receptor blockers, ACE inhibitors, or direct renin inhibitors (such as aliskiren) is associated with increased risks of hypotension, syncope, hyperkalemia, and changes in renal function (including acute renal failure) compared to monotherapy.

The Veterans Affairs Nephropathy in Diabetes (VA NEPHRON-D) trial enrolled 1448 patients with type 2 diabetes, elevated urinary-albumin-to-creatinine ratio, and decreased estimated glomerular filtration rate (GFR 30 to 89.9 ml/min), randomized them to lisinopril or placebo on a background of losartan therapy and followed them for a median of 2.2 years. Patients receiving the combination of losartan and lisinopril did not obtain any additional benefit compared to monotherapy for the combined endpoint of decline in GFR, end stage renal disease, or death, but experienced an increased incidence of hyperkalemia and acute kidney injury compared with the monotherapy group.

In general, avoid combined use of RAS inhibitors. Monitor blood pressure, renal function and electrolytes in patients on PRINIVIL and other agents that affect the RAS.

Do not coadminister aliskiren with PRINIVIL in patients with diabetes. Avoid use of aliskiren with PRINIVIL in patients with renal impairment (GFR <60 ml/min).

### **7.5 Lithium**

Lithium toxicity has been reported in patients receiving lithium concomitantly with drugs, which cause elimination of sodium, including ACE inhibitors. Lithium toxicity was usually reversible upon discontinuation of lithium and the ACE inhibitor. Monitor serum lithium levels during concurrent use.

## 7.6 Gold

Nitritoid reactions (symptoms include facial flushing, nausea, vomiting and hypotension) have been reported rarely in patients on therapy with injectable gold (sodium aurothiomalate) and concomitant ACE inhibitor therapy including PRINIVIL.

## 7.7 Mammalian Target of Rapamycin (mTOR) Inhibitors

Patients taking concomitant mTOR inhibitor (e.g., temsirolimus, sirolimus, everolimus) therapy may be at increased risk for angioedema [see *Warnings and Precautions* (5.2)].

## 7.8 Neprilysin Inhibitors

Patients taking a concomitant neprilysin inhibitor (e.g., sacubitril) may be at increased risk for angioedema [see *Contraindications* (4) and *Warnings and Precautions* (5.2)].

# 8 USE IN SPECIFIC POPULATIONS

## 8.1 Pregnancy

### *Pregnancy Category D*

Use of drugs that act on the renin-angiotensin system during the second and third trimesters of pregnancy reduces fetal renal function and increases fetal and neonatal morbidity and death. Resulting oligohydramnios can be associated with fetal lung hypoplasia and skeletal deformations. Potential neonatal adverse effects include skull hypoplasia, anuria, hypotension, renal failure, and death. When pregnancy is detected, discontinue PRINIVIL as soon as possible. These adverse outcomes are usually associated with the use of these drugs in the second and third trimester of pregnancy. Most epidemiologic studies examining fetal abnormalities after exposure to antihypertensive use in the first trimester have not distinguished drugs affecting the renin-angiotensin system from other antihypertensive agents. Appropriate management of maternal hypertension during pregnancy is important to optimize outcomes for both mother and fetus.

In the unusual case that there is no appropriate alternative therapy to drugs affecting the renin-angiotensin system for a particular patient, apprise the mother of the potential risk to the fetus. Perform serial ultrasound examinations to assess the intra-amniotic environment. If oligohydramnios is observed, discontinue PRINIVIL, unless it is considered lifesaving for the mother. Fetal testing may be appropriate, based on the week of pregnancy. Patients and physicians should be aware, however, that oligohydramnios may not appear until after the fetus has sustained irreversible injury. Closely observe infants with histories of *in utero* exposure to PRINIVIL for hypotension, oliguria, and hyperkalemia [see *Use in Specific Populations* (8.4)].

## 8.3 Nursing Mothers

Milk of lactating rats contains radioactivity following administration of <sup>14</sup>C lisinopril. It is not known whether this drug is secreted in human milk. Because many drugs are secreted in human milk, and because of the potential for serious adverse reactions in nursing infants from ACE inhibitors, discontinue nursing or discontinue PRINIVIL.

## 8.4 Pediatric Use

Antihypertensive effects and safety of PRINIVIL have been established in pediatric patients aged 6 to 16 years [see *Dosage and Administration* (2.1) and *Clinical Studies* (14.1)]. No relevant differences between the adverse reaction profile for pediatric patients and adult patients were identified.

Safety and effectiveness of PRINIVIL have not been established in pediatric patients under the age of 6 or in pediatric patients with glomerular filtration rate <30 mL/min/1.73 m<sup>2</sup> [see *Clinical Pharmacology* (12.3) and *Clinical Studies* (14.1)].

### Neonates with a History of in Utero Exposure to PRINIVIL

If oliguria or hypotension occurs, direct attention toward support of blood pressure and renal perfusion.

Exchange transfusions or dialysis may be required as a means of reversing hypotension and/or substituting for disordered renal function.

### 8.5 Geriatric Use

No dosage adjustment with PRINIVIL is necessary in elderly patients. In a clinical study of PRINIVIL in patients with myocardial infarctions (GISSI-3 Trial) 4,413 (47%) were 65 and over, while 1,656 (18%) were 75 and over. In this study, 4.8% of patients aged 75 years and older discontinued PRINIVIL treatment because of renal dysfunction vs. 1.3% of patients younger than 75 years. No other differences in safety or effectiveness were observed between elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out.

### 8.6 Race

ACE inhibitors, including PRINIVIL, have an effect on blood pressure that is less in Black patients than in non-Blacks.

### 8.7 Renal Impairment

Dose adjustment of PRINIVIL is required in patients undergoing hemodialysis or whose creatinine clearance is  $\leq 30$  mL/min. No dose adjustment of PRINIVIL is required in patients with creatinine clearance  $>30$  mL/min [see *Dosage and Administration* (2.4) and *Clinical Pharmacology* (12.3)].

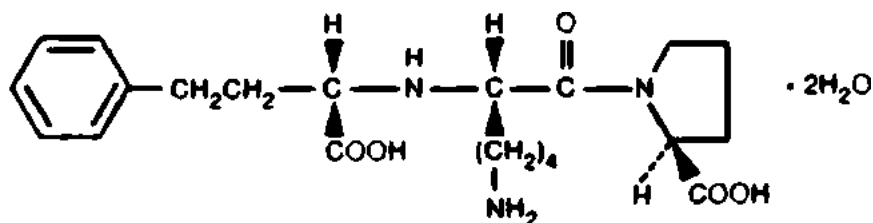
## 10 OVERDOSAGE

Following a single oral dose of 20 g/kg, no lethality occurred in rats and death occurred in one of 20 mice receiving the same dose. The most likely manifestation of overdosage would be hypotension, for which the usual treatment would be intravenous infusion of normal saline solution.

Lisinopril can be removed by hemodialysis [see *Warnings and Precautions* (5.2)].

## 11 DESCRIPTION

PRINIVIL contains lisinopril, a synthetic peptide derivative, and an oral, long-acting angiotensin converting enzyme inhibitor. Lisinopril is chemically described as (S)-1-[N<sup>2</sup>-(1-carboxy-3-phenylpropyl)-L-lysyl]-L-proline dihydrate. Its empirical formula is  $C_{21}H_{31}N_3O_5 \cdot 2H_2O$  and its structural formula is:



Lisinopril is a white to off-white, crystalline powder, with a molecular weight of 441.52. It is soluble in water and sparingly soluble in methanol and practically insoluble in ethanol.

PRINIVIL is supplied as 5 mg, 10 mg, and 20 mg tablets for oral administration. In addition to the active ingredient, lisinopril, each tablet contains the following inactive ingredients: calcium phosphate, mannitol, magnesium stearate, and starch. The 10 mg and 20 mg tablets also contain iron oxide.

## 12 CLINICAL PHARMACOLOGY

### 12.1 Mechanism of Action

Lisinopril inhibits angiotensin converting enzyme (ACE) in human subjects and animals. ACE is a peptidyl dipeptidase that catalyzes the conversion of angiotensin I to the vasoconstrictor substance, angiotensin II. Angiotensin II also stimulates aldosterone secretion by the adrenal cortex. The beneficial effects of lisinopril in hypertension and heart failure appear to result primarily from suppression of the renin-

angiotensin-aldosterone system. Inhibition of ACE results in decreased plasma angiotensin II which leads to decreased vasopressor activity and to decreased aldosterone secretion. The latter decrease may result in a small increase of serum potassium. In hypertensive patients with normal renal function treated with PRINIVIL alone for up to 24 weeks, the mean increase in serum potassium was approximately 0.1 mEq/L; however, approximately 15% of patients had increases greater than 0.5 mEq/L and approximately 6% had a decrease greater than 0.5 mEq/L. In the same study, patients treated with PRINIVIL and hydrochlorothiazide for up to 24 weeks had a mean decrease in serum potassium of 0.1 mEq/L; approximately 4% of patients had increases greater than 0.5 mEq/L and approximately 12% had a decrease greater than 0.5 mEq/L [see *Warnings and Precautions* (5.5)]. Removal of angiotensin II negative feedback on renin secretion leads to increased plasma renin activity.

ACE is identical to kininase, an enzyme that degrades bradykinin. Whether increased levels of bradykinin, a potent vasodepressor peptide, play a role in the therapeutic effects of PRINIVIL remains to be elucidated.

While the mechanism through which PRINIVIL lowers blood pressure is believed to be primarily suppression of the renin-angiotensin-aldosterone system, PRINIVIL is antihypertensive even in patients with low-renin hypertension. Although PRINIVIL was antihypertensive in all races studied, Black hypertensive patients (usually a low-renin hypertensive population) had a smaller average response to monotherapy than non-Black patients.

Concomitant administration of PRINIVIL and hydrochlorothiazide further reduced blood pressure in Black and non-Black patients and any racial difference in blood pressure response was no longer evident.

## **12.2 Pharmacodynamics**

### *Hypertension*

**Adult Patients:** Administration of PRINIVIL to patients with hypertension results in a reduction of supine and standing blood pressure to about the same extent with no compensatory tachycardia. Symptomatic postural hypotension is usually not observed although it can occur and should be anticipated in volume and/or salt-depleted patients [see *Warnings and Precautions* (5.3)]. When given together with thiazide-type diuretics, the blood pressure lowering effects of the two drugs are approximately additive.

In most patients studied, onset of antihypertensive activity was seen at one hour after oral administration of an individual dose of PRINIVIL, with peak reduction of blood pressure achieved by 6 hours. Although an antihypertensive effect was observed 24 hours after dosing with recommended single daily doses, the effect was more consistent and the mean effect was considerably larger in some studies with doses of 20 mg or more than with lower doses. However, at all doses studied, the mean antihypertensive effect was substantially smaller 24 hours after dosing than it was 6 hours after dosing.

The antihypertensive effects of PRINIVIL are maintained during long-term therapy. Abrupt withdrawal of PRINIVIL has not been associated with a rapid increase in blood pressure or a significant increase in blood pressure compared to pretreatment levels.

## **12.3 Pharmacokinetics**

**Adult Patients:** Following oral administration of PRINIVIL, peak serum concentrations of lisinopril occur within about 7 hours, although there was a trend to a small delay in time taken to reach peak serum concentrations in acute myocardial infarction patients. Declining serum concentrations exhibit a prolonged terminal phase which does not contribute to drug accumulation. This terminal phase probably represents saturable binding to ACE and is not proportional to dose. Upon multiple dosing, lisinopril exhibits an effective half-life of 12 hours.

Lisinopril does not appear to be bound to other serum proteins. Lisinopril does not undergo metabolism and is excreted unchanged entirely in the urine. Based on urinary recovery, the mean extent of absorption of lisinopril is approximately 25 percent, with large inter-subject variability (6-60 percent) at all doses tested (5-80 mg). Lisinopril absorption is not influenced by the presence of food in the gastrointestinal

tract. The absolute bioavailability of lisinopril is reduced to about 16 percent in patients with stable NYHA Class II-IV congestive heart failure, and the volume of distribution appears to be slightly smaller than that in normal subjects.

The oral bioavailability of lisinopril in patients with acute myocardial infarction is similar to that in healthy volunteers.

Impaired renal function decreases elimination of lisinopril, which is excreted principally through the kidneys, but this decrease becomes clinically important only when the glomerular filtration rate is below 30 mL/min. Above this glomerular filtration rate, the elimination half-life is little changed. With greater impairment, however, peak and trough lisinopril levels increase, time to peak concentration increases and time to attain steady state is prolonged. Older patients, on average, have (approximately doubled) higher blood levels and area under the plasma concentration time curve (AUC) than younger patients [see *Dosage and Administration* (2.1)]. Lisinopril can be removed by hemodialysis.

Studies in rats indicate that lisinopril crosses the blood-brain barrier poorly. Multiple doses of lisinopril in rats do not result in accumulation in any tissues. Milk of lactating rats contains radioactivity following administration of  $^{14}\text{C}$  lisinopril. By whole body autoradiography, radioactivity was found in the placenta following administration of labeled drug to pregnant rats, but none was found in the fetuses.

***Pediatric Patients:*** The pharmacokinetics of lisinopril were studied in 29 pediatric hypertensive patients between 6 years and 16 years with glomerular filtration rate  $>30\text{ mL/min/1.73 m}^2$ . After doses of 0.1 to 0.2 mg/kg, steady state peak plasma concentrations of lisinopril occurred within 6 hours and the extent of absorption based on urinary recovery was about 28%. These values are similar to those obtained previously in adults. The typical value of lisinopril oral clearance (systemic clearance/absolute bioavailability) in a child weighing 30 kg is 10 L/h, which increases in proportion to renal function.

## **13 NONCLINICAL TOXICOLOGY**

### **13.1 Carcinogenesis, Mutagenesis, Impairment of Fertility**

There was no evidence of a tumorigenic effect when lisinopril was administered for 105 weeks to male and female rats at doses up to 90 mg per kg per day or for 92 weeks to male and female mice at doses up to 135 mg per kg per day. These doses are 10 times and 7 times, respectively, the MRHDD when compared on a body surface area basis.

Lisinopril was not mutagenic in the Ames microbial mutagen test with or without metabolic activation. It was also negative in a forward mutation assay using Chinese hamster lung cells. Lisinopril did not produce single strand DNA breaks in an *in vitro* alkaline elution rat hepatocyte assay. In addition, lisinopril did not produce increases in chromosomal aberrations in an *in vitro* test in Chinese hamster ovary cells or in an *in vivo* study in mouse bone marrow.

There were no adverse effects on reproductive performance in male and female rats treated with up to 300 mg/kg/day of lisinopril (33 times the MRHDD when compared on a body surface area basis).

Studies in rats indicate that lisinopril crosses the blood brain barrier poorly. Multiple doses of lisinopril in rats do not result in accumulation in any tissues. Milk of lactating rats contains radioactivity following administration of  $^{14}\text{C}$  lisinopril. By whole body autoradiography, radioactivity was found in the placenta following administration of labeled drug to pregnant rats, but none was found in the fetuses.

## **14 CLINICAL STUDIES**

### **14.1 Hypertension**

***Adult Patients:*** Two dose-response studies utilizing a once daily regimen were conducted in 438 mild to moderate hypertensive patients not on a diuretic. Blood pressure was measured 24 hours after dosing. An antihypertensive effect of PRINIVIL was seen with 5 mg in some patients. However, in both studies

blood pressure reduction occurred sooner and was greater in patients treated with 10, 20, or 80 mg of PRINIVIL. In controlled clinical studies in patients with mild to moderate hypertension, PRINIVIL 20-80 mg has been compared to hydrochlorothiazide 12.5-50 mg and with atenolol 50-500 mg, and in patients with moderate, to severe hypertension to metoprolol 100-200 mg. It was superior to hydrochlorothiazide in effects on systolic and diastolic blood pressure in a population that was 75% Caucasian. PRINIVIL was approximately equivalent to atenolol and metoprolol in effects on diastolic blood pressure and had somewhat greater effects on systolic blood pressure.

PRINIVIL had similar effectiveness and adverse effects in younger and older (>65 years) patients. It was less effective in Blacks than in Caucasians.

In hemodynamic studies of PRINIVIL in patients with essential hypertension, blood pressure reduction was accompanied by a reduction in peripheral arterial resistance with little or no change in cardiac output and in heart rate. In a study in nine hypertensive patients, following administration of PRINIVIL, there was an increase in mean renal blood flow that was not significant. Data from several small studies are inconsistent with respect to the effect of lisinopril on glomerular filtration rate in hypertensive patients with normal renal function, but suggest that changes, if any, are not large.

In patients with renovascular hypertension PRINIVIL has been shown to be well tolerated and effective in reducing blood pressure [see *Warnings and Precautions* (5.3)].

***Pediatric Patients:*** In a clinical study involving 115 hypertensive pediatric patients 6 to 16 years of age, patients who weighed <50 kg received either 0.625, 2.5, or 20 mg of lisinopril daily and patients who weighed ≥50 kg received either 1.25, 5, or 40 mg of lisinopril daily. At the end of 2 weeks, lisinopril administered once daily lowered trough blood pressure in a dose-dependent manner with consistent antihypertensive efficacy demonstrated at doses >1.25 mg (0.02 mg/kg). This effect was confirmed in a withdrawal phase, where the diastolic pressure rose by about 9 mmHg more in patients randomized to placebo than it did in patients who were randomized to remain on the middle and high doses of lisinopril. The dose-dependent antihypertensive effect of lisinopril was consistent across several demographic subgroups: age, Tanner stage, gender, and race. In this study, lisinopril was generally well-tolerated.

In the above pediatric studies, lisinopril was given either as tablets or in a suspension for those children and infants who were unable to swallow tablets or who required a lower dose than is available in tablet form [see *Dosage and Administration* (2.5)].

#### **14.2 Heart Failure**

In two placebo controlled, 12-week clinical studies compared the addition of PRINIVIL up to 20 mg daily to digitalis and diuretics alone. The combination of PRINIVIL, digitalis and diuretics reduced the following signs and symptoms of heart failure: edema, rales, paroxysmal nocturnal dyspnea and jugular venous distention. In one of the studies, the combination of PRINIVIL, digitalis and diuretics reduced orthopnea, presence of third heart sound and the number of patients classified as NYHA Class III and IV, and it improved exercise tolerance. A large (over 3000 patients) survival study, the ATLAS Trial, comparing 2.5 and 35 mg of lisinopril in patients with systolic heart failure, showed that the higher dose of lisinopril had outcomes at least as favorable as the lower dose. During baseline-controlled clinical trials, in patients receiving digitalis and diuretics, single doses of PRINIVIL resulted in decreases in pulmonary capillary wedge pressure, systemic vascular resistance and blood pressure accompanied by an increase in cardiac output and no change in heart rate.

#### **14.3 Acute Myocardial Infarction**

The Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico (GISSI-3) study was a multicenter, controlled, randomized, unblinded clinical trial conducted in 19,394 patients with acute myocardial infarction (MI) admitted to a coronary care unit. It was designed to examine the effects of short-term (6 week) treatment with lisinopril, nitrates, their combination, or no therapy on short-term (6 week) mortality and on long-term death and markedly impaired cardiac function. Hemodynamically-stable patients presenting within 24 hours of the onset of symptoms were randomized, in a 2 x 2 factorial design, to 6 weeks of either 1) PRINIVIL alone (n=4841), 2) nitrates alone (n=4869), 3) PRINIVIL plus nitrates

(n=4841), or 4) open control (n=4843). All patients received routine therapies, including thrombolytics (72%), aspirin (84%), and a beta blocker (31%), as appropriate, normally utilized in acute myocardial infarction (MI) patients.

The protocol excluded patients with hypotension (systolic blood pressure  $\leq 100$  mmHg), severe heart failure, cardiogenic shock, and renal dysfunction (serum creatinine  $>2$  mg/dL and/or proteinuria  $>500$  mg per 24 h). Patients randomized to PRINIVIL received 5 mg within 24 hours of the onset of symptoms, 5 mg after 24 hours, and then 10 mg daily thereafter. Patients with systolic blood pressure less than 120 mmHg at baseline received 2.5 mg of PRINIVIL. If hypotension occurred, the PRINIVIL dose was reduced or if severe hypotension occurred PRINIVIL was stopped [see *Dosage and Administration* (2.3)].

The primary outcomes of the trial were the overall mortality at 6 weeks and a combined endpoint at 6 months after the myocardial infarction, consisting of the number of patients who died, had late (day 4) clinical congestive heart failure, or had extensive left ventricular damage defined as ejection fraction  $\leq 35\%$ , or an akinetic-dyskinetic [A-D] score  $\geq 45\%$ . Patients receiving PRINIVIL (n=9646), alone or with nitrates, had an 11% lower risk of death (p =0.04) compared to patients who did not receive PRINIVIL (n=9672) (6.4% vs. 7.2%, respectively) at 6 weeks. Although patients randomized to receive PRINIVIL for up to 6 weeks also fared numerically better on the combined endpoint at 6 months, the open nature of the assessment of heart failure, substantial loss to follow-up echocardiography, and substantial excess use of PRINIVIL, between 6 weeks and 6 months in the group randomized to 6 weeks of lisinopril, preclude any conclusion about this endpoint.

Patients with acute myocardial infarction, treated with PRINIVIL, had a higher (9.0% versus 3.7%) incidence of persistent hypotension (systolic blood pressure  $<90$  mmHg for more than 1 hour) and renal dysfunction (2.4% versus 1.1%) in-hospital and at 6 weeks (increasing creatinine concentration to over 3 mg/dL or a doubling or more of the baseline serum creatinine concentration) [see *Adverse Reactions* (6.1)].

## 16 HOW SUPPLIED/STORAGE AND HANDLING

PRINIVIL is supplied as oval-shaped, compressed tablets scored on one side.

|       | Color        | Printing | Unit of use<br>Bottle/90 |
|-------|--------------|----------|--------------------------|
| 5 mg  | White        | MSD 19   | NDC 0006-0019-54         |
| 10 mg | Light yellow | MSD 106  | NDC 0006-0106-54         |
| 20 mg | Peach        | MSD 207  | NDC 0006-0207-54         |

### *Storage*

Store at controlled room temperature, 15-30°C (59-86°F), and protect from moisture.

Dispense in a tight container, if product package is subdivided.

## 17 PATIENT COUNSELING INFORMATION

NOTE: This information is intended to aid in the safe and effective use of this medication. It is not a disclosure of all possible adverse or intended effects.

***Pregnancy:*** Tell female patients of childbearing age about the consequences of exposure to PRINIVIL during pregnancy. Discuss treatment options with women planning to become pregnant. Tell patients to report pregnancies to their physicians as soon as possible.

**Angioedema:** Angioedema, including laryngeal edema, may occur at any time during treatment with angiotensin converting enzyme inhibitors, including PRINIVIL. Tell patients to report immediately any signs or symptoms suggesting angioedema (swelling of face, extremities, eyes, lips, tongue, difficulty in swallowing or breathing) and to take no more drug until they have consulted with the prescribing physician.

**Symptomatic Hypotension:** Tell patients to report light-headedness especially during the first few days of therapy. If actual syncope occurs, tell the patient to discontinue the drug until they have consulted with the prescribing physician.

Tell patients that excessive perspiration and dehydration may lead to an excessive fall in blood pressure because of reduction in fluid volume. Other causes of volume depletion such as vomiting or diarrhea may also lead to a fall in blood pressure; advise patients accordingly.

**Hyperkalemia:** Tell patients not to use salt substitutes containing potassium without consulting their physician.

**Hypoglycemia:** Tell diabetic patients treated with oral antidiabetic agents or insulin starting an ACE inhibitor to monitor for hypoglycemia closely, especially during the first month of combined use [see *Drug Interactions* (7.2)].

**Leukopenia/Neutropenia:** Tell patients to report promptly any indication of infection (e.g., sore throat, fever), which may be a sign of leukopenia/neutropenia.

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