RIFATER® (rifampin, isoniazid and pyrazinamide USP) Tablets

WARNING
Severe and sometimes fatal hepatitis associated with isoniazid therapy may occur and may develop even after many months of treatment. The risk of developing hepatitis is age related. Approximate case rates by age are: 0 per 1,000 for persons under 20 years of age, 3 per 1,000 for persons in the 20 to 34 year age group, 12 per 1,000 for persons in the 35 to 49 year age group, 23 per 1,000 for persons in the 50 to 64 year age group, and 8 per 1,000 for persons over 65 years of age. The risk of hepatitis is increased with daily consumption of alcohol. Precise data to provide a fatality rate for isoniazid-related hepatitis is not available; however, in a U.S. Public Health Service Surveillance Study of 13,858 persons taking isoniazid, there were 8 deaths among 174 cases of hepatitis.

Therefore, patients given isoniazid should be carefully monitored and interviewed at monthly intervals. Serum transaminase concentration becomes elevated in about 10% to 20% of patients, usually during the first few months of therapy; but it can occur at any time. Usually enzyme levels return to normal despite continued use of drug, but in some cases progressive liver dysfunction occurs. Patients should be instructed to report immediately any of the prodromal symptoms of hepatitis, such as fatigue, weakness, malaise, anorexia, nausea, or vomiting. If these symptoms appear or if signs suggestive of hepatic damage are detected, isoniazid should be discontinued promptly since continued use of the drug in these cases has been reported to cause a more severe form of liver damage.

Patients with tuberculosis should be given appropriate treatment with alternative drugs. If isoniazid must be reinstated, it should be reinstated only after symptoms and laboratory abnormalities have cleared. The drug should be restarted in very small and gradually increasing doses and should be withdrawn immediately if there is any indication of recurrent liver involvement. Treatment should be deferred in persons with acute hepatic diseases.

DESCRIPTION
RIFATER (rifampin/isoniazid/pyrazinamide USP) tablets contain 120 mg rifampin, 50 mg isoniazid, and 300 mg pyrazinamide for use in antibacterial therapy. The tablets also contain as inactive ingredients: povidone, carboxymethyl cellulose sodium, calcium stearate, sodium lauryl sulfate, sucrose, t alc, acacia, titanium dioxide, magnesium carbonate, colloidal silicon dioxide, dried aluminum hydroxide gel, ferric oxide, black iron oxide, carnauba wax, white beeswax, carboxymethyl cellulose sodium, calcium stearate, sodium lauryl sulfate, sucrose, talc, and black iron oxide.

CLINICAL PHARMACOLOGY
General
In a single-dose bioavailability study of five RIFATER tablets (Treatment A, n=23) versus RIFADIN 600 mg, isoniazid 250 mg, and pyrazinamide 1500 mg (Treatment B, n=24) administered concurrently in healthy subjects, there was no difference in extent of absorption, as measured by the area under the plasma concentration versus time curve (AUC), of all three components. However, the mean peak plasma concentration of rifampin was approximately 18% lower following the single-dose administration of RIFATER tablets as compared to RIFADIN administered in combination with pyrazinamide and isoniazid. Mean (±SD) pharmacokinetic parameters are summarized in the following table.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cmax (mcg/mL)</th>
<th>Half-life (hr)</th>
<th>Apparent Oral Clearance (L/hr)</th>
<th>Bioavailability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Isoniazid</td>
<td>3.09 ± 0.88</td>
<td>3.14 ± 0.92</td>
<td>2.80 ± 1.02</td>
<td>2.80 ± 1.11</td>
</tr>
<tr>
<td></td>
<td>24.02 ±15.29</td>
<td>25.72 ±16.38</td>
<td>100.6 ±16.6</td>
<td></td>
</tr>
<tr>
<td>Rifampin</td>
<td>11.04 ± 3.08</td>
<td>13.61 ± 3.96</td>
<td>3.19 ± 0.63</td>
<td>3.41 ± 0.86</td>
</tr>
<tr>
<td></td>
<td>9.62 ± 3.00</td>
<td>8.30 ± 2.50</td>
<td>88.8 ±16.5</td>
<td></td>
</tr>
<tr>
<td>Pyrazinamide</td>
<td>28.02 ± 4.52</td>
<td>29.21 ± 4.35</td>
<td>10.04 ± 1.54</td>
<td>10.08 ± 1.29</td>
</tr>
<tr>
<td></td>
<td>3.82 ± 0.65</td>
<td>3.70 ± 0.59</td>
<td>96.8 ± 7.6</td>
<td></td>
</tr>
</tbody>
</table>

Mean (±SD) pharmacokinetic parameters are summarized in the following table.

The effect of food on the pharmacokinetics of RIFATER tablets was not studied.

Rifampin
Rifampin is readily absorbed from the gastrointestinal tract. Peak serum levels in healthy adults and pediatric populations vary widely from individual to individual. Following a single 600 mg oral dose of rifampin in healthy adults, the peak serum level averages 7 mcg/mL but may vary from 4 to 32 mcg/mL. Absorption of rifampin is reduced by about 30% when the drug is ingested with food.

In healthy adults, the biological half-life of rifampin in serum averages 3.35 ± 0.66 hours after a 600 mg oral dose, with increases up to 5.08 ± 2.45 hours reported after a 900 mg dose. With repeated administration, the half-life decreases and reaches average values of approximately 2 to 3 hours. The half-life does not differ in patients with renal failure at doses not exceeding 600 mg daily and, consequently, no dosage adjustment is required. The half-life of rifampin at a dose of 720 mg daily has not been established in patients with renal failure. Following a single 900 mg oral dose of rifampin in patients with varying degrees of renal insufficiency, the mean half-life increased from 3.6 hours in healthy adults to 5.0, 7.3, and 11.0 hours in patients with glomerular filtration rates of 30–50 mL/min, less than 30 mL/min, and in anuric patients, respectively. Refer to the WARNINGS section for information regarding patients with hepatic insufficiency.

After absorption, rifampin is rapidly eliminated in the bile, and an enterohepatic circulation ensues. During this process, rifampin undergoes progressive deacetylation so that nearly all the drug in the bile is in this form in about 6 hours. This metabolite has antibacterial activity. Intestinal reabsorption is reduced by deacetylation, and elimination is facilitated. Up to 30% of a dose is excreted in the urine, with about half as unchanged drug.

Rifampin is widely distributed throughout the body. It is present in effective concentrations in many organs and body fluids, including cerebrospinal fluid. Rifampin is about 80% protein bound. Most of the unbound fraction is not ionized and therefore is diffused freely in tissues.

Pediatrics
In one study, pediatric patients 6 to 58 months old were given rifampin suspended in simple syrup or as dry powder mixed with apple sauce at a dose of 10 mg/kg body weight. Peak serum concentrations of 10.7 ± 3.7 and 11.5 ± 5.1 mcg/mL were obtained 1 hour after preprandial ingestion of the drug suspension and the apple sauce mixture, respectively. After the administration of either preparation, the t1/2 of rifampin averaged 2.9 hours.

It should be noted that in other studies in pediatric populations, at doses of 10 mg/kg body weight, mean peak serum concentrations of 3.5 mcg/mL to 15 mcg/mL have been reported.

Isoniazid
Isoniazid is the hydrazide of isonicotinic acid. It is a colorless or white crystalline powder or white or colorless crystals. It is odorous and slowly absorbed by exposure to air and light. It is freely soluble in water, sparingly soluble in alcohol and slightly soluble in chloroform and in ether. Its molecular weight is 137.14 and its chemical formula is C9H7N2O. The chemical name for isoniazid is 4-pyridinecarboxylic acid, hydrazide and its structural formula is:

\[ \text{CONH}_2 \]

Pyrazinamide
Pyrazinamide, the pyrazine analog of nicotinamide, is a white, crystalline powder, stable at room temperature, and sparingly soluble in water. The chemical name for pyrazinamide is pyrazinecarboxamide and its molecular weight is 123.11. Its chemical formula is C9H7N2O and its structural formula is:

\[ \text{CONH}_2 \]
Pyridoxine (B6) deficiency is sometimes observed in adults with high doses of isoniazid and is probably due to its competition with pyridoxal phosphate for the enzyme apotryptophanase.

**Pyrazinamide**

Pyrazinamide is well absorbed from the gastrointestinal tract and attains peak plasma concentrations within 2 hours. Plasma concentrations generally range from 30 to 50 mcg/mL, with doses of 20 to 25 mg/kg. It is widely distributed in body tissues and fluids, including the liver, lungs, and cerebrospinal fluid (CSF). The CSF concentration is approximately equal to concurrent steady-state plasma concentrations in patients with inflamed meninges. Pyrazinamide is approximately 10% bound to plasma proteins. The plasma half-life of pyrazinamide is 9 to 10 hours in patients with normal renal and hepatic function. The halflife of the drug may be prolonged in patients with impaired renal or hepatic function. Pyrazinamide is hydrolyzed in the liver to its major active metabolite, pyrazinoic acid. Pyrazinoic acid is hydroxylated to the main excretory product, 5-hydroxy-pyrazinoic acid. Within 24 hours, approximately 70% of an oral dose of pyrazinamide is excreted in urine, mainly by glomerular filtration. About 4% to 14% of the dose is excreted as unchanged drug; the remainder is excreted as metabolites.

**Microbiology**

**Mechanism of Action**

Rifampin

Rifampin inhibits DNA-dependent RNA polymerase activity in susceptible Mycobacterium tuberculosis organisms. Specifically, it interacts with bacterial RNA polymerase, but does not inhibit the mammalian enzyme.

Isoniazid

Isoniazid inhibits the biosynthesis of mycolic acids which are major components of the cell wall of Mycobacterium tuberculosis.

**Pyrazinamide**

The exact mechanism of action by which pyrazinamide inhibits the growth of Mycobacterium tuberculosis organisms is unknown.

**Drug Resistance**

Organisms resistant to rifampin are likely to be resistant to other rifamycins. β-lactamase production should have no effect on rifampin activity.

In the treatment of tuberculosis, the small number of resistant cells present within large populations of susceptible cells can rapidly become predominant. In addition, resistance to rifampin has been documented to occur as single-step mutations of the DNA-dependent RNA polymerase. Since resistance can emerge rapidly, appropriate susceptibility tests should be performed in the event of persistent positive cultures.

**Activity in vitro and in vivo**

Rifampin, isoniazid, and pyrazinamide at therapeutic levels have demonstrated bactericidal activity against both intracellular and extracellular Mycobacterium tuberculosis organisms (see INDICATIONS AND USAGE).

Pyrazinamide alone is only active at a slightly acidic pH (pH 5.5) in vitro and in vivo. Isoniazid kills actively growing tubercle bacilli.

**Susceptibility Testing**

Prior to initiation of therapy, appropriate specimens should be collected for identification of the infecting organism and in vitro susceptibility tests.

In vitro testing for Mycobacterium tuberculosis isolates:

Two standardized in vitro susceptibility methods are available for testing isoniazid, rifampin, and pyrazinamide against Mycobacterium tuberculosis organisms. The agar proportion method (CDC or CLSI M24-A) utilizes Middlebrook 7H10 medium impregnated with isoniazid at 0.2 and 1.0 mcg/mL and rifampin at 1.0 mcg/mL for the final concentrations of drugs. The final concentration for pyrazinamide is 25.0 mcg/mL at pH 5.5. After 3 weeks of incubation MIC<sub>50</sub> values are calculated by comparing the quantity of organisms growing in the medium containing drug to the control cultures. Mycobacterial growth in the presence of drug ≥1% of the control indicates resistance.

The radiometric broth method employs the BACTEC 460 machine to compare the growth index from untreated control cultures to cultures grown in the presence of 0.2 and 1.0 mcg/mL of isoniazid and 2.0 mcg/mL of rifampin. Strict adherence to the manufacturer's instructions for sample processing and data interpretation is required for this assay. The radiometric broth method has not been approved for the testing of pyrazinamide.

Susceptibility test results obtained by the two different methods can only be compared if the appropriate rifampin or isoniazid concentrations are used for each test method as indicated above. Both test procedures require the use of Mycobacterium tuberculosis H37Rv, ATP<sub>29</sub>, as a control organism.

The clinical relevance of in vitro susceptibility test results for mycobacterial species other than Mycobacterium tuberculosis using either the radiometric broth method or the proportion method has not been determined.

**CLINICAL TRIAL**

A total of 220 patients were enrolled in an open label, prospective, randomized, parallel group, active controlled trial, for the treatment of pulmonary tuberculosis. There were 241 patients evaluable for efficacy, 123 patients received isoniazid, rifampin and pyrazinamide as separate tablets and capsules for 56 days, and 118 patients received 4 to 6 RIFATER tablets based on body weight for 56 days. RIFATER tablets and the drugs dosed as separate tablets and capsules were administered based on body weight during the intensive phase of treatment according to the following table.

**Dose of Isoniazid, Rifampin and Pyrazinamide Administered as Separate Drugs**

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Isoniazid (mg)</th>
<th>Rifampin (mg)</th>
<th>Pyrazinamide (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>300</td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>≥55</td>
<td>300</td>
<td>600</td>
<td>2000</td>
</tr>
</tbody>
</table>

**Dose of Isoniazid, Rifampin and Pyrazinamide Administered as RIFATER**

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Number of Tablets</th>
<th>Isoniazid (mg)</th>
<th>Rifampin (mg)</th>
<th>Pyrazinamide (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;54</td>
<td>4</td>
<td>200</td>
<td>480</td>
<td>1200</td>
</tr>
<tr>
<td>45 to 54</td>
<td>5</td>
<td>250</td>
<td>600</td>
<td>1500</td>
</tr>
<tr>
<td>≥55</td>
<td>6</td>
<td>300</td>
<td>720</td>
<td>1800</td>
</tr>
</tbody>
</table>

During the continuation phase, both treatment groups received 450 mg of rifampin and 300 mg of isoniazid per day for 4 months if the patient weighed <50 kg or 600 mg of rifampin and 300 mg of isoniazid per day for 4 months if the patient weighed ≥50 kg. Patients were followed for occurrence of relapses for up to 30 months after the end of therapy.

There were no significant differences in the negative bacteriological sputum results (available in a subset of patients) between the two treatments at 2 and 6 months during the trial and during the follow-up period. See table below.

**Negative Sputums/No. of Patients (Percent Negative)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2 Months</th>
<th>6 Months</th>
<th>Follow-Up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIFATER</td>
<td>99/108 (95%)</td>
<td>100/104 (96%)</td>
<td>99/101 (98%)</td>
</tr>
<tr>
<td>Separate†</td>
<td>99/108 (92%)</td>
<td>95/96 (99%)</td>
<td>105/106 (99%)</td>
</tr>
</tbody>
</table>

*The median follow-up time for all the RIFATER patients was 756 days with a range of 42 to 1325 days and 745 days with a range of 50 to 1427 days for the patients dosed with separate tablets and capsules.

Rifampin, isoniazid, and pyrazinamide dosed as separate tablets and capsules.

For adverse events, see ADVERSE REACTIONS.

**INDICATIONS AND USAGE**

RIFATER is indicated in the initial phase of the short-course treatment of pulmonary tuberculosis. During this phase, which should last 2 months, RIFATER should be administered on a daily, continuous basis (See DOSAGE AND ADMINISTRATION).

Following the initial phase and treatment with RIFATER, treatment should be continued with rifampin and isoniazid (e.g., RIFAMATE) for at least 4 months. Treatment should be continued for a longer period of time if the patient is still sputum or culture positive, if resistant organisms are present, or if the patient is HIV positive.

In the treatment of tuberculosis, the small number of resistant cells present within large populations of susceptible cells can rapidly become the predominant type. Since resistance can emerge rapidly, susceptibility tests should be performed in the event of persistent positive cultures during the course of treatment. Bacteriologic smears or cultures should be obtained before the start of therapy to confirm the susceptibility of the organism to rifampin, isoniazid, and pyrazinamide and they should be followed throughout therapy to monitor response to the treatment. If test results show resistance to any of the components of RIFATER and the patient is not responding to therapy, the drug regimen should be modified.

**CONTRAINDICATIONS**

RIFATER is contraindicated in patients with a history of hypersensitivity to rifampin, isoniazid, pyrazinamide or any of the components, or to any of the rifamycins.

Rifampin is contraindicated in patients who are also receiving methotrexate due to an increased risk of severe hepatocellular toxicity. (See PRECAUTIONS, Drug Interactions.)

Pyrazinamide is contraindicated in patients who are also receiving nitrofurantoin due to possible potentiation of toxicity of both drugs. (See PRECAUTIONS, Drug Interactions.)

Isoniazid is contraindicated in patients with severe hepatic disease; severe adverse reactions to isoniazid, such as drug fever, chills, and arthritis; patients with acute liver disease of any etiology; and patients with acute gout.

**WARNINGS**

RIFATER is a combination of the three drugs, rifampin, isoniazid, and pyrazinamide. Each of these individual drugs has been associated with liver dysfunction.

Systemic hypersensitivity reactions, including Drug Reaction with Eosinophilia and Systemic Symptoms (DRESS) syndrome, may occur in patients receiving RIFATER. (See ADVERSE REACTIONS.) Signs and symptoms of hypersensitivity reactions may include fever, urticaria, angioedema, hypotension, acute bronchospasm, conjunctivitis, thrombocytopenia, neutropenia, elevated liver transaminases or flu-like syndrome (weakness, fatigue, muscle pain, nausea, vomiting, headache, chills, aches, itching, sweats, dizziness, shortness of breath, chest pain, cough, syncope, palpitations). These reactions may be severe and may be fatal. Manifestations of hypersensitivity, such as fever, lymphenodapathy or laboratory abnormalities (including eosinophilia, liver abnormalities) may be present even though rash is not evident. Monitor patients receiving RIFATER for signs and symptoms of hypersensitivity reactions. If these signs or symptoms occur, discontinue RIFATER and administer supportive measures.

Rifampin

Rifampin has been shown to produce liver dysfunction. Fatalities associated with jaundice have occurred in patients with liver disease and in patients taking rifampin with other hepatotoxic agents. Because RIFATER contains both rifampin and isoniazid, it should only be given with caution and under strict medical supervision to patients with impaired liver function. In these patients, careful monitoring of liver function, especially serum glutamic pyruvic transaminase (SGPT) and serum glutamic oxaloacetate transaminase (SGOT) should be carried out prior to therapy and then every 2 to 4 weeks during therapy. If signs of hepatocellular damage occur, RIFATER should be withdrawn.

In some cases, hyperbilirubinemia resulting from competition between rifampin and bilirubin for excretory pathways of the liver at the cell level can occur in the early days of...
isoniazid (see the boxed WARNING). Because RIFATER contains pyrazinamide, patients started on RIFATER should be used with caution in patients with a history of diabetes mellitus, as if signs of hepatocellular damage or hyperuricemia accompanied by an acute gouty arthropathy. Hyperuricemia accompanied by an acute gouty arthritis occurs without decreased function, the patient should be transferred to a regimen not containing pyrazinamide.

PRECAUTIONS

General

RIFATER should be used with caution in patients with a history of diabetes mellitus, as if signs of hepatocellular damage or hyperuricemia accompanied by an acute gouty arthropathy. Hyperuricemia accompanied by an acute gouty arthritis occurs without decreased function, the patient should be transferred to a regimen not containing pyrazinamide.

Pyrazinamide

Pyrazinamide inhibits renal excretion of urates, frequently resulting in hyperuricemia which is usually asymptomatic. If hyperuricemia is accompanied by acute gouty arthritis, RIFATER, because it contains pyrazinamide, should be discontinued.

Information for Patients

Food Interactions

Because isoniazid has some monooamine oxidase inhibiting activity, an interaction with tyramine-containing foods (cheese, red wine) may occur. Diamine oxidase may also be inhibited, causing exaggerated response (e.g., headache, sweating, palpitations, flushing, hypotension) to foods containing histamine (e.g., skipjack, tuna, other tropical fish). Tyramine- and histamine-containing foods should be avoided in patients receiving RIFATER.

RIFATER, because it contains rifampin, may produce a reddish coloration of the urine, sweat, sputum, and tears, and the patient should be forewarned of this. Soft contact lenses may be permanently stained.

The patient should be advised that the reliability of oral or other systemic hormonal contraceptives may be affected; consideration should be given to using alternative contraceptive measures. Patients should be instructed to take RIFATER either 1 hour before or 2 hours after a meal with a full glass of water.

RIFATER should be used with caution in patients with a history of tuberculosis, as if signs of hepatocellular damage or hyperuricemia accompanied by an acute gouty arthropathy. Hyperuricemia accompanied by an acute gouty arthritis occurs without decreased function, the patient should be transferred to a regimen not containing pyrazinamide.

Compliance with the full course of therapy must be emphasized, and the importance of not missing any doses must be stressed.

Laboratory Tests

Adults treated for tuberculosis with RIFATER should have baseline measurements of hepatic enzymes, bilirubin, serum creatinine, a complete blood count (CBC) and platelet count (or estimate), and blood uric acid.

Patients should be seen at least monthly during therapy and should be specifically questioned concerning symptoms associated with adverse reactions. All patients with abnormalities should have follow-up, including laboratory testing, if necessary. Routine laboratory monitoring for toxicity in people with normal baseline measurements is generally not necessary.

Drug Interactions

Rifampin

Patients who received rifampin 600 mg once daily concomitantly with saquinavir 1000 mg/ritonavir 100 mg twice daily (ritonavir-boosted saquinavir) developed severe hepatocellular toxicity. Therefore, concomitant use of these medications is contraindicated. (See CONTRAINDICATIONS.)

Enzyme Induction: Rifampin is known to induce certain cytochrome P-450 enzymes.

Coadministration of RIFATER, because it contains rifampin, with drugs that undergo biotransformation through these metabolic pathways may accelerate elimination. To maintain optimum therapeutic blood levels, dosages of drugs metabolized by these pathways may require adjustment when starting or stopping concomitantly administered rifampin.

Rifampin has been reported to substantially decrease the plasma concentrations of the following antiviral drugs: atazanavir, darunavir, fosamprenavir, saquinavir, and tipranavir. These antiviral drugs must not be coadministered with rifampin. (See CONTRAINDICATIONS.)

Rifampin has been reported to accelerate the metabolism of the following drugs: anticonvulsants (e.g., phenytoin), digoxin, antithrombin (e.g., warfarin), mexiletine, quinidine, tocainide, oral anticoagulants, antifungals (e.g., fluconazole, itraconazole, ketoconazole), barbiturates, beta-blockers, calcium channel blockers (e.g., diltiazem, nifedipine, verapamil), chloramphenicol, clarithromycin, fluoroquinolones (e.g., ciprofloxacin), corticosteroids, cyclosporine, cardiac glycoside preparations, clotbrate, oral or other systemic hormonal contraceptives, dapsone, diazepam, doxycycline, haloperidol, oral hypoglycemic agents (sulfonylureas), levothyroxine, methadone, naltrexone, nicotine, pantoprazole, propoxyphene, quinine, tacrolimus, theophylline, tricyclic antidepressants (e.g., amitryptiline, nortriptyline), and zidovudine. It may be necessary to adjust dosages of these drugs if they are given concurrently with RIFATER since it contains rifampin.

Patients using oral or other systemic hormonal contraceptives should be advised to change to nonhormonal methods of birth control during rifampin therapy. RIFATER has been observed to increase the requirements for anticoagulant drugs of the coumarin type. In patients receiving anticoagulants and RIFATER concurrently, it is recommended that the prothrombin time be performed daily or as frequently as necessary to establish and maintain the required dose of anticoagulant.

When the two drugs were taken concomitantly, decreased concentrations of atovaquone and increased concentrations of rifampin were observed. Concurrent use of ketoconazole and rifampin has resulted in decreased serum concentrations of both drugs. Concurrent use of rifampin and enalapril has resulted in decreased concentrations ofenalapril, the active metabolite of enalapril. Since RIFATER contains rifampin, dosage adjustments should be made if RIFATER is concurrently administered with ketoconazole or enalapril if indicated by the patient’s clinical condition.

Other Interactions

Concomitant antacid administration may reduce the absorption of rifampin. Daily doses of RIFATER, because it contains rifampin, should be given at least 1 hour before the ingestion of antacids.

Probenicid and cimetidine have been reported to increase the blood level of rifampin. When rifampin is given concomitantly with either halothane or isoniazid the potential for hepatotoxicity is increased. The concomitant use of RIFATER, because it contains both rifampin and isoniazid, and halothane should be avoided. Patients receiving both rifampin and isoniazid and as in RIFATER should be monitored closely for hepatotoxicity. (See the boxed WARNING.)

Plasma concentrations of sulphasalazine may be reduced following the concomitant administration of sulphasalazine and RIFATER because it contains rifampin. This finding may be the result of alterations in the colonic bacteria responsible for the reduction of sulphasalazine to sulpyridine and mesalamine.

Isoniazid Enzyme Inhibition: Isoniazid is known to inhibit certain cytochrome P-450 enzymes.

Coadministration of isoniazid with drugs that undergo biotransformation through these metabolic pathways may decrease elimination. Consequently, dosages of drugs metabolized by these enzymes may require adjustment when starting or stopping concomitantly administered RIFATER, because it contains isoniazid, to maintain optimum therapeutic blood levels.

Isoniazid has been reported to inhibit the metabolism of the following drugs: anticonvulsants (e.g., carbamazepine, phenytoin, primidone, valproic acid), benzodiazepines (e.g., diazepam, haloperidol), ketoconazole, theophylline, and warfarin. It may be necessary to adjust the dosages of these drugs if they are given concurrently with RIFATER because it contains isoniazid. The impact of the competing effects of rifampin and isoniazid on the metabolism of these drugs is unknown.

Other Interactions

Concomitant antacid administration may reduce the absorption of isoniazid. Ingestion of food may also reduce the absorption of isoniazid. Daily doses of RIFATER, because it contains isoniazid, should be given on an empty stomach at least 1 hour before the ingestion of antacids or food.

Corticosteroids (e.g., prednisolone) may decrease the serum concentration of isoniazid by increasing acetylation rate and/or renal clearance. Para-aminosalicylic acid may increase the plasma concentration and elimination half-life of isoniazid by competition of acetylation enzymes.

Pharmacodynamic Interactions

Daily ingestion of alcohol may be associated with a higher incidence of isoniazid hepatitis. Isoniazid, when given concomitantly with rifampin, has been reported to increase the hepatotoxicity of both drugs. Patients receiving both rifampin and isoniazid as in RIFATER should be monitored closely for hepatotoxicity. The CNS effects of meperidine (drowsiness), cycloserine (dizziness, drowsiness), and disulfiram (acute behavioral and coordination changes) may be exaggerated when concomitant RIFATER, because it contains isoniazid, is given. Concurrent RIFATER, because it contains isoniazid, and levodopa administration may produce symptoms of
excess catecholamine stimulation (agitation, flushing, palpitations) or lack of levodopa effect.

Isoenzymes may produce hyperglycemia and lead to loss of glucose control in patients on oral hypoglycemics.

Fast acetylation of isoniazid may produce high concentrations of hydrazine that facilitate detoxification of enflurane. Renal function should be monitored in patients receiving both RifATER and enfurane.

Food Interactions

Because isoniazid has some monooxime oxidase inhibiting activity, an interaction with tyramine-containing foods (cheese, red wine) may occur. Diamine oxidase may also be inhibited, causing exaggerated response (e.g., headache, sweating, palpitations, flushing, hypotension) to foods containing histamine (e.g., skimjack, tuna, other tropical fish). Tyramine- and histamine-containing foods should be avoided by patients receiving RifATER.

Drug/Laboratory Test Interactions

Rifampin

Cross-reactivity and false-positive urine screening tests for opiates have also been reported in patients receiving rifampin when using the KIM’s (Kinetic Interaction of Micro particles in Solution) method (e.g., Abuscreen Orline opiates assay; Roche Diagnostic Systems). Confirmatory tests, such as gas chromatography/mass spectrometry, will distinguish rifampin from opiates.

Therapeutic levels of rifampin have been shown to inhibit standard microbiological assays for serum folate and vitamin B12. Therefore, alternative assay methods should be considered. Transient abnormalities in liver function tests (e.g., elevations in serum bilirubin, alkaline phosphatase and serum transaminases), and reduced biliary excretion of contrast media used for visualization of the gallbladder have also been observed. Therefore, these tests should be performed before the morning dose of RifATER.

Rifampin and isoniazid have been reported to alter vitamin D metabolism. In some cases, reduced levels of circulating 25-hydroxy vitamin D and 1,25-dihydroxy vitamin D have been accompanied by reduced serum calcium and phosphate, and elevated parathyroid hormone.

Pyrazinamide

Pyrazinamide has been reported to interfere with ACETEST and KETOSTIX urine tests to produce a pink-brown color.

Carcinogenesis, Mutagenesis, Impairment of Fertility

Increased frequency of chromosomal aberrations was observed in vitro in lymphocytes obtained from patients treated with combinations of rifampin, isoniazid, and pyrazinamide and combinations of streptomycin, rifampin, isoniazid, and pyrazinamide.

Rifampin

A few cases of accelerated growth of lung carcinoma have been reported in man, but a causal relationship with the drug has not been established. Hepatomas were increased in female (C3Hf/DP) mice dosed for 60 weeks with rifampicin followed by an observation period of 30 weeks. The increase in hepatocellular tumors was not statistically significant in all six studies performed in rats using the NTP (National Toxicology Program).

There was no evidence of mutagenicity in male C3H/HE mice or in similar studies in BALB/c mice, or in two year studies in Wistar rats.

There was no evidence of mutagenicity in both prokaryotic (Salmonella typhi, Escherichia coli) and eukaryotic (Saccharomyces cerevisiae) bacteria, Drosophila melanogaster, or ICR/HA Swiss mice. An increase in chromatic breaks was noted when whole blood cell cultures were treated with rifampin. Increased frequency of chromosomal aberrations was observed in vitro in lymphocytes obtained from patients treated with combinations of rifampin, isoniazid, and pyrazinamide and combinations of streptomycin, rifampin, isoniazid, and pyrazinamide.

Isoenzymes

Isoniazid has been reported to induce pulmonary tumors in a number of strains of mice.

Pyrazinamide

Pyrazinamide was not carcinogenic in lifetime bioassays in rats (at doses up to 500 mg/kg, about three times the recommended human dose, based on body surface area comparisons) or mice (at doses up to 2000 mg/kg, about five times the recommended human dose, based on body surface area comparisons).

Pyrazinamide was not mutagenic in the Ames bacterial test, but induced chromosomal aberrations in human lymphocyte cell cultures.

Pregnancy – Teratogenic Effects

Category C: Although animal reproduction studies have not been conducted with RifATER teratogenic effects (including cleft palate and spina bifida) have been observed in rodents treated with rifampin at doses of 0.2 to 2 times the maximum recommended human dose, based on body surface area comparisons. There are no adequate and well-controlled studies of RifATER in pregnant women. RifATER should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Rifampin

Congenital malformations, primarily spina bifida were increased in the offspring of pregnant rats given rifampin during organogenesis at oral doses of 150 to 250 mg/kg/day (about 1 to 2 times the maximum recommended human dose based on body surface area comparison). The incidence increased in a dose-dependent fashion in fetuses of pregnant mice treated at oral doses of 50 to 200 mg/kg (about 0.2 to 0.8 times the maximum recommended human dose based on body surface area comparisons). Imperfect osteogenesis and embryotoxicity were also reported in pregnant rabbits given rifampin at oral doses up to 200 mg/kg/day (about 3 times the maximum recommended daily human dose based on body surface area comparisons). Although there are no adequate and well-controlled studies in pregnant women, rifampin has been reported to cross the placental barrier and appear in cord blood.

Isoniazid

It has been reported that in both rats and rabbits, isoniazid may exert an embryocidal effect when administered orally during pregnancy, although no isoniazid-related congenital anomalies have been found in reproduction studies in mammalian species (mice, rats, and rabbits).

Pyrazinamide

Animal reproductive studies have not been conducted with pyrazinamide. It is also not known whether pyrazinamide can cause fetal harm when administered to a pregnant woman.

Pregnancy – Non-Teratogenic Effects

When administered during the last few weeks of pregnancy, rifampin can cause post-natal hemorrhages in the mother and infant for which treatment with vitamin K may be indicated.

Rifampin

When administered during the last few weeks of pregnancy, rifampin can cause postnatal hemorrhages in the mother and infant. In this case, treatment with vitamin K may be indicated for postnatal hemorrhage.

Nursing Mothers

Since rifampin, isoniazid, and pyrazinamide are known to pass into maternal breast milk, a decision should be made whether to discontinue nursing or to discontinue RifATER, taking into account the importance of the drug to the mother.

Pediatric Use

Safety and effectiveness in pediatric patients under the age of 15 have not been established. (See CLINICAL PHARMACOLOGY, General; See also DOSAGE AND ADMINISTRATION)

Geriatric Use

Clinical studies of RifATER did not include sufficient numbers of subjects aged 65 and over to determine whether they respond differently from younger subjects. Other reported clinical experience has not identified differences in responses between the elderly and younger patients. Caution should therefore be observed in using rifampin and isoniazid in elderly patients. (See WARNINGS)

ADVERSE REACTIONS

Adverse Experiences During the Clinical Trial

Adverse event data reported for the RifATER and the separate drug treatment groups during the first 2 months of the trial are shown in the table below.
with the use of rifampin (and other broad spectrum antibiotics). Therefore, it is important to consider this diagnosis in patients who develop diarrhea in association with antibiotic use.

**Hepatic**

Transient abnormalities in liver function tests (e.g., elevations in serum bilirubin, alkaline phosphatase, and serum transaminases) have been observed. Rarely, hepatitis or a shock-like syndrome with hepatic involvement and abnormal liver function tests has been reported.

**Hematologic**

Thrombocytopenia has occurred primarily with high dose intermittent therapy, but has also been noted once after resumption of interrupted treatment. It rarely occurs during well-supervised daily therapy. This effect is reversible if the drug is discontinued as soon as purpura occurs. Cerebral hemorrhage and fatalities have been reported when rifampin administration has been continued or resumed after the appearance of purpura. Rare reports of disseminated intravascular coagulation have been observed. Leukopenia, hemolytic anemia, and decreased hemoglobin have been observed. Agranulocytosis has been reported rarely.

**Central Nervous System**

Headache, fever, drowsiness, fatigue, ataxia, dizziness, inability to concentrate, mental confusion, behavioral changes, muscular weakness, pains in extremities, and generalized numbness have been observed. Psychoses have been rarely reported. Rare reports of myopathy have also been observed.

**Visual disturbances have been observed.**

**Endocrine**

Menstrual disturbances have been observed. Rare reports of adrenal insufficiency in patients with compromised adrenal function have been observed.

**Renal**

Elevations in BUN and serum uric acid have been reported. Rarely, hemolysis, hemoglobinuria, hematuria, interstitial nephritis, acute tubular necrosis, renal insufficiency, and acute renal failure have been noted. These are generally considered to be hypersensitivity reactions. They usually occur during intermittent therapy or when treatment is resumed following intentional or accidental interruption of a daily dosage regimen, and are reversible when rifampin is discontinued and appropriate therapy instituted.

**Dermatologic**

Cutaneous reactions are mild and self-limiting and do not appear to be hypersensitivity reactions. Typically, they consist of flushing and itching with or without a rash. More serious cutaneous reactions which may be due to hypersensitivity occur but are uncommon.

**Hypersensitivity Reactions**

Occasionally pruritus, urticaria, rash, pemphigoid reaction, erythema multiforme including Stevens-Johnson syndrome, toxic epidermal necrolysis, Drug Reaction with Eosinophilia and Systemic Symptoms syndrome (see WARNINGS), vasculitis, eosinophilia, sore mouth, sore tongue and conjunctivitis have been observed.

Anaphylaxis has been reported rarely.

**Miscellaneous**

Edema of the face and extremities has been reported. Other reactions which have occurred with intermittent dosage regimes include “flu” syndrome (such as episodes of fever, chills, headache, dizziness, and bone pain), shortness of breath, wheezing, decrease in blood pressure and shock. The “flu” syndrome may also appear if rifampin is taken irregularly by the patient or if daily administration is resumed after a drug free interval.

**Isoniazid**

The most frequent reactions are those affecting the nervous system and the liver. (See the boxed WARNING)

**Nervous System**

Peripheral neuropathy is the most common toxic effect. It is dose-related, occurs most often in the marnished and in those predisposed to neuritis (e.g., alcoholics and diabetics), and is usually preceded by paresthesia of the feet and hands. The incidence is higher in “slow inactivators.”

Other neurotoxic effects, which are uncommon with conventional doses, are convulsions, toxic encephalopathy, optic neuritis and atrophy, memory impairment, and toxic psychosis.

**Gastrointestinal**

Pancreatitis, nausea, vomiting, and epigastric distress.

**Hepatic**

Elevated serum transaminases (SGOT, SGPT), bilirubinemia, bilirubinuria, jaundice, and occasionally severe and sometimes fatal hepatitis. The common prodromal symptoms are anorexia, nausea, vomiting, fatigue, malaise, and weakness. Mild and transient elevation of serum transaminase levels occurs in 10 to 20% of persons taking isoniazid. The abnormality usually occurs in the first 4 to 6 months of treatment but can occur at any time during therapy. In most instances, enzyme levels return to normal with no necessity to discontinue medication. In occasional instances, progressive liver damage occurs, with accompanying symptoms. In these cases, the drug should be discontinued immediately. The frequency of liver damage is rare. It is rare in persons under 20, but occurs in up to 2.3% of those over 50 years of age.

**Hematologic**

Agranulocytosis; hemolytic, sideroblastic, or aplastic anemia; thrombocytopenia; and eosinophilia.

**Hypersensitivity Reactions**

Fever, skin eruptions (morbilliform, maculopapular, purpuric, or exfoliative), lymphadenopathy, anaphylactic reactions, Stevens-Johnson syndrome, toxic epidermal necrolysis (see WARNINGS, Isoniazid), Drug Reaction with Eosinophilia and Systemic Symptoms syndrome (see WARNINGS), and vasculitis.

**Metabolic and Endocrine**

Pyridoxine deficiency, pellagra, hyperglycemia, metabolic acidosis, and gyenecostasis.

**Miscellaneous**

Rheumatic syndrome and systemic lupus erythematosus-like syndrome.

**Pyrazinamide**

The principal adverse effect is a hepatic reaction (See WARNINGS). Hepatotoxicity appears to be dose related and may appear at any time during therapy. Pyrazinamide can cause hyperuricemia and gout (See PRECAUTIONS).

**Gastrointestinal**

GI disturbances including nausea, vomiting, and anorexia have also been reported.

**Hematologic and Lymphatic**

Thrombocytopenia and sideroblastic anemia with erythroid hyperplasia, vacuolation of erythrocytes and increased serum concentration have occurred rarely with this drug.

Edema of the face and extremities has been reported. Other reactions which have occurred with intermittent dosage regimes include “flu” syndrome may also appear if rifampin is taken irregularly by the patient or if daily administration is resumed after a drug free interval.

**Isoniazid**

Untreated or inadequately treated cases of gross isoniazid overdosage can be fatal, but good response has been reported in most patients treated within the first few hours after drug ingestion.

The minimum acute lethal or toxic dose is not well established. However, nonfatal acute overdoses in adults have been reported with doses ranging from 9 to 12 gm rifampin. Fatal acute overdoses in adults have been reported with doses ranging from 14 to 60 gm. Alcohol or a history of alcohol abuse was involved in some of the fatal and nonfatal reports. Nonfatal overdoses in pediatric patients ages 1 to 4 years old of 100 mg/kg for one to two doses has been reported.

Isoniazid overdosage produces signs and symptoms within 30 minutes to 3 hours. Nausea, vomiting, dizziness, slurring of speech, blurring of vision, and visual hallucinations (including bright colors and strange designs) are among the early manifestations. With more severe overdosage, respiratory distress and CNS depression, progressing rapidly from stupor to profound coma, are to be expected along with severe, intractable seizures. Severe metabolic acidosis, acetonuria, and hyperglycemia are typical laboratory findings.

**Pyrazinamide**

In one case of pyrazinamide overdosage, abnormal liver function tests developed. These spontaneously reverted to normal when the drug was stopped.

**Treatment**

The airway should be secured and adequate respiratory exchange should be established in cases of overdosage with RIFATER. Only then should gastric emptying (lavage-aspiration) be attempted; this may be difficult because of seizures. Obtain blood samples for immediate determination of gases, electrolytes, BUN, glucose, etc. and type and cross-match blood in preparation for possible hemodialysis. Gastric lavage within the first 2 to 3 hours after ingestion is advisable, but it should not be attempted once convulsions are under control. To treat convulsions, administer IV diazepam or short-acting barbiturates, and IV pyridoxine (usually 1 mg/1 mg isoniazid ingested). Following evacuation of gastric contents, the instillation of activated charcoal slurry into the stomach may help absorb any remaining drug from the gastrointestinal tract. Another consideration may be to control severe nausea and vomiting.

**RAPID CONTROL OF METABOLIC ACIDOSIS IS FUNDAMENTAL TO MANAGEMENT.** Give IV sodium bicarbonate at once and repeat as needed, adjusting subsequent dosage on the basis of laboratory findings (e.g., serum sodium, pH, etc.). Forced osmotic diuresis must be started early and should be continued for some hours after clinical improvement to hasten renal clearance of drug and help prevent relapse; monitor fluid intake and output.

Bile drainage may be indicated in presence of serious impairment of hepatic function lasting more than 24–48 hours. Under these circumstances and for severe cases, extracorporeal hemodialysis may be required; if this is not available, peritoneal dialysis can be used along with forced diuresis.

Along with measures based on initial and repeated determination of blood gases and other laboratory tests as needed, utilize meticulous respiratory and other intensive care to protect against hypoxia, hypotension, aspiration pneumonitis, etc.
Untreated or inadequately treated cases of gross isoniazid overdosage can terminate fatally, but good response has been reported in most patients brought under adequate treatment within the first few hours after drug ingestion.

**DOSAGE AND ADMINISTRATION**

**RIFATER** is recommended in the initial phase of short-course therapy which is usually continued for 2 months. The Advisory Council for the Elimination of Tuberculosis, the American Thoracic Society, and the Centers for Disease Control and Prevention recommend that either streptomycin or ethambutol be added as a fourth drug in a regimen containing isoniazid (INH), rifampin and pyrazinamide for initial treatment of tuberculosis unless the likelihood of INH or rifampin resistance is very low. The need for a fourth drug should be reassessed when the results of susceptibility testing are known. If community rates of INH resistance are currently less than 4%, an initial treatment regimen with less than four drugs may be considered.

Following the initial phase, treatment should be continued with rifampin and isoniazid (e.g., RIFAMATE®) for at least 4 months. Treatment should be continued for longer if the patient is still sputum or culture positive, if resistant organisms are present, or if the patient is HIV positive.

Concomitant administration of pyridoxine (B6) is recommended in the malnourished, in those predisposed to neuropathy (e.g., alcoholics and diabetics), and in adolescents. See **CLINICAL PHARMACOLOGY**, General, for dosing information in patients with renal failure.

**Adults**

Patients should be given the following single daily dose of RIFATER either 1 hour before or 2 hours after a meal with a full glass of water.

- Patients weighing ≤44 kg – 4 tablets
- Patients weighing between 45–54 kg – 5 tablets
- Patients weighing ≥55 kg – 6 tablets

**Pediatric Patients**

The ratio of the drugs in RIFATER may not be appropriate in pediatric patients under the age of 15 (e.g., higher mg/kg doses of isoniazid are usually given in pediatric patients than adults).

**HOW SUPPLIED**

RIFATER tablets are light beige, smooth, round, and shiny sugar-coated tablets imprinted with “RIFATER” in black ink and contain 120 mg rifampin, 50 mg isoniazid, and 300 mg pyrazinamide, and are supplied as:

- Bottles of 60 tablets (NDC 0088-0576-41).

**Storage**

Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F) [see USP Controlled Room Temperature]. Protect from excessive humidity.

**Reference**


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