

PRODUCT MONOGRAPH

PrZAXINE

Rifaximin

550 mg tablets

Antibacterial agent

WHO ATC A07AA11

Manufactured by:

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PrZAXINE

Rifaximin

PART I: HEALTH PROFESSIONAL INFORMATION

SUMMARY PRODUCT INFORMATION

Route of Administration	Dosage Form / Strength	Clinically Relevant Nonmedicinal Ingredients
Oral	550 mg tablet	None <i>For a complete listing see Dosage Forms, Composition and Packaging section.</i>

INDICATIONS AND CLINICAL USE

Hepatic Encephalopathy

ZAXINE® (rifaximin) is indicated for the reduction in risk of overt hepatic encephalopathy (HE) recurrence in patients \geq 18 years of age.

In the trials of ZAXINE for HE, 91% of the patients were treated with lactulose concomitantly or were on lactulose treatment concomitantly. Differences in the treatment effect on those patients not using lactulose concomitantly could not be assessed.

ZAXINE has not been studied in patients with MELD (Model for End-Stage Liver Disease) scores $>$ 25, and only 8.6% of patients in the controlled trial had MELD scores over 19. There is increased systemic exposure to rifaximin in patients with hepatic dysfunction.

To reduce the development of drug-resistant bacteria and maintain the effectiveness of rifaximin, ZAXINE should only be used for the authorized indication and clinical use.

Irritable Bowel Syndrome with Diarrhea

ZAXINE is indicated for the treatment of irritable bowel syndrome with diarrhea (IBS-D) in adults.

In the trials of ZAXINE for IBS-D, patients who experienced a recurrence of symptoms and who responded to a first treatment were safely and effectively retreated for up to 2 times. Current clinical trials have not evaluated the safety and efficacy of three or more repeat treatments for IBS-D. **Geriatrics ($>$ 65 years of age):**

Studies specifically designed to determine the dose in elderly patients have not been performed. In the controlled trial with ZAXINE, 19.4% were aged 65 years and over, while 2.3% were 75 and over. No overall differences in safety or effectiveness were observed between these

subjects and younger subjects, and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out.

Pediatrics (< 18 years of age):

The safety and effectiveness of ZAXINE in the prevention of overt hepatic encephalopathy (HE) recurrence or treatment of irritable bowel syndrome with diarrhea (IBS-D) has not been investigated in children and adolescents under 18 years of age.

CONTRAINDICATIONS

ZAXINE (rifaximin) is contraindicated in patients with a hypersensitivity to rifaximin, any of the rifamycin antimicrobial agents, or any of the ingredients in ZAXINE (See **DOSAGE FORMS, COMPOSITION AND PACKAGING** for a complete listing. See also **WARNINGS AND PRECAUTIONS – Immune**, and **ADVERSE REACTIONS**).

WARNINGS AND PRECAUTIONS

General

Not for Systemic Infections

ZAXINE (rifaximin) acts locally on the microflora of the gut and should not be used for the treatment of systemic bacterial infections.

Low systemic absorption of rifaximin has been noted in healthy individuals, but absorption is increased in subjects with impaired hepatic function. (See **WARNINGS AND PRECAUTIONS, Hepatic/Biliary/Pancreatic**). There is the potential for increased systemic exposure to rifaximin in disease states in which intestinal barrier function or gut motility is altered. Rifaximin exposure is slightly higher in patients with inflammatory bowel disease (2.3- and 4.3-fold increases in C_{max} and AUC, respectively) or irritable bowel syndrome (1.8- and 1.7-fold increases in C_{max} and AUC, respectively) than in healthy subjects receiving the same doses.

The effect on the gut flora following long-term use of rifaximin is not known.

Susceptibility/Resistance

Development of Drug Resistant Bacteria

Prescribing ZAXINE in the absence of the authorized indications is unlikely to provide benefit to the patient and risks the development of drug-resistant bacteria.

Carcinogenicity

A possible relationship between Zaxine treatment and carcinogenicity cannot be ruled out. A 2-year rat study with administration of rifaximin alfa- at doses of 150 to 250 mg/kg/day (doses equivalent to 1.3 to 2.2 times the recommended human dose, based on relative body surface area

comparisons) showed an increased trend in malignant schwannomas of the heart in male rats, but not female rats. (See **TOXICOLOGY, Carcinogenicity**).

Gastrointestinal

Clostridium difficile-Associated Disease

Clostridium difficile-associated disease (CDAD) has been reported with use of nearly all antibacterial agents, including ZAXINE (see **ADVERSE REACTIONS**), and may range in severity from mild diarrhea to fatal colitis. Treatment with antibacterial agents alters the normal flora of the colon which may lead to overgrowth of *C. difficile*.

C. difficile produces toxins A and B which contribute to the development of CDAD. Hypertoxin producing strains of *C. difficile* cause increased morbidity and mortality, as these infections can be refractory to antimicrobial therapy and may require colectomy. CDAD must be considered in all patients who present with diarrhea following antibiotic use. Careful medical history is necessary since CDAD has been reported to occur over two months after the administration of antibacterial agents.

If CDAD is suspected or confirmed, ongoing antibiotic use not directed against *C. difficile* may need to be discontinued. Appropriate fluid and electrolyte management, protein supplementation, antibiotic treatment of *C. difficile*, and surgical evaluation should be instituted as clinically indicated.

Intestinal Obstruction

Zaxine has not been studied for use in prevention of hepatic encephalopathy or treatment of IBS-D in patients with intestinal obstruction; use in patients with an intestinal obstruction is not recommended.

Hepatic/Biliary/Pancreatic

Following administration of ZAXINE 550 mg twice daily to patients with a history of hepatic encephalopathy, the systemic exposure to rifaximin was increased with increasing hepatic impairment. The AUC_{tau} was about 10-, 13-, and 20-fold higher in those patients with mild (Child-Pugh A), moderate (Child-Pugh B) and severe (Child-Pugh C) hepatic impairment, respectively, compared to that in healthy subjects (see **ACTION AND CLINICAL PHARMACOLOGY, Pharmacokinetics**). The highest systemic exposure to rifaximin was seen in patients with severe hepatic impairment. Additionally, the clinical trials were limited to patients with MELD scores <25. Therefore, caution should be exercised when administering ZAXINE to patients with severe (Child-Pugh C) hepatic impairment.

Immune

Hypersensitivity Reactions

Acute hypersensitivity reactions, including dyspnea, rash, pruritus, angioedema and anaphylaxis, have been reported with rifaximin (see **ADVERSE REACTIONS**). If a severe hypersensitivity reaction occurs, ZAXINE should be discontinued and appropriate therapy should be instituted.

Renal

The pharmacokinetics of rifaximin in patients with impaired renal function have not been studied.

Special Populations

Pregnant Women:

There are no adequate and well controlled studies in pregnant women. ZAXINE tablets should not be used during pregnancy unless the potential benefit to the mother outweighs the potential risk to the fetus.

Fetal rat malformations were observed in a study of pregnant rats administered a high dose of rifaximin that is equivalent to the therapeutic dose in patients with hepatic encephalopathy (based upon plasma AUC comparisons). Fetal rabbit malformations were observed from pregnant rabbits administered mid and high rifaximin doses that resulted in less than 0.1 times the dose in patients with hepatic encephalopathy, based upon plasma AUC comparisons. (See **TOXICOLOGY**).

Nursing Women:

It is not known whether ZAXINE is excreted in human milk. Because many drugs are excreted in human milk and because of the potential for adverse reactions from ZAXINE in nursing infants, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatrics (< 18 years of age):

The safety and effectiveness of ZAXINE have not been established in patients < 18 years of age.

Geriatrics (> 65 years of age):

In the controlled trial with ZAXINE for hepatic encephalopathy, 19.4% were 65 and over, while 2.3% were 75 and over. In the controlled trial with ZAXINE for irritable bowel syndrome 11% were 65 and over, while 2% were 75 and over. No overall differences in safety or effectiveness were observed between these subjects and younger subjects, and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out.

ADVERSE REACTIONS

Adverse Drug Reaction Overview

The most common adverse reactions in the clinical and post-marketing setting are GI-related (e.g. diarrhea, nausea), the most serious of which is *C. difficile*-associated diarrhea. Rash, pruritus, pyrexia, anemia, dyspnea, arthralgia, muscle spasms and peripheral edema were also commonly reported with rifaximin use (1-15 %) and were seen at a higher frequency than in the placebo group.

Clinical Trial Adverse Drug Reactions

Because clinical trials are conducted under very specific conditions the adverse reaction rates observed in the clinical trials may not reflect the rates observed in practice and should not be compared to the rates in the clinical trials of another drug. Adverse drug reaction information from clinical trials is useful for identifying drug-related adverse events and for approximating rates.

Hepatic Encephalopathy

The safety of rifaximin in patients in remission from hepatic encephalopathy (HE) was evaluated in two studies, a randomized, double-blind, placebo-controlled Phase 3 study, RFHE3001, and a long-term, open-label study, RFHE3002.

Study RFHE3001 compared 140 patients treated with rifaximin (dose 550 mg twice daily for 6 months) to 159 patients treated with placebo, while study RFHE3002 treated 322 patients, of whom 152 were from the RFHE3001 study, with rifaximin 550 mg twice daily for 12 months (66% of patients) and for 24 months (39% of patients), for a median exposure of 512.5 days.

All adverse reactions that occurred in patients treated with rifaximin at an incidence $\geq 5\%$ and at a higher incidence ($\geq 1\%$) than placebo patients in RFHE3001 are reported in [Table 1](#).

Table 1: Adverse Events Occurring in $\geq 5\%$ of Patients Receiving Rifaximin and at a Higher Incidence than Placebo in Study RFHE3001

MedDRA System Organ Class	Event	Placebo N = 159 n (%)	Rifaximin (550 mg BID) N = 140 n (%)
Blood and lymphatic system disorders	Anaemia	6 (3.8)	11 (7.9)
Gastrointestinal disorders	Ascites	15 (9.4)	16 (11.4)
	Nausea	21 (13.2)	20 (14.3)
	Abdominal pain upper	8 (5.0)	9 (6.4)
General disorders and administration site conditions	Oedema peripheral	13 (8.2)	21 (15.0)
	Pyrexia	5 (3.1)	9 (6.4)
Musculoskeletal and connective tissue disorders	Muscle spasms	11 (6.9)	13 (9.3)
	Arthralgia	4 (2.5)	9 (6.4)
Nervous system disorders	Dizziness	13 (8.2)	18 (12.9)
Psychiatric disorders	Depression	8 (5.0)	10 (7.1)
Respiratory, thoracic and mediastinal	Dyspnoea	7 (4.4)	9 (6.4)

MedDRA System Organ Class	Event	Placebo N = 159 n (%)	Rifaximin (550 mg BID) N = 140 n (%)
disorders			
Skin and subcutaneous tissue disorders	Pruritus	10 (6.3)	13 (9.3)
	Rash	6 (3.8)	7 (5.0)

Table 2 includes rifaximin adverse drug reactions (considered drug-related by the investigator) observed in the placebo-controlled study RFHE3001 and the long term study RFHE3002 at an incidence $\geq 1\%$.

Table 2: Drug-Related TEAEs in $\geq 1\%$ of Rifaximin- or Placebo-Treated Subjects – (Study RFHE3001 and All Rifaximin Subjects from RFHE3001 and RFHE3002)

MedDRA System Organ Class Preferred Term	Event	RFHE3001		RFHE3001 and RFHE3002
		Placebo (N = 159) n (%)	Rifaximin 550 mg BID (N = 140) n (%)	All Rifaximin 550 mg BID (N = 392) n (%)
Gastrointestinal disorders	Diarrhea	11 (6.9)	5 (3.6)	9 (2.3)
	Nausea	12 (7.5)	4 (2.9)	10 (2.6)
	Abdominal distension	2 (1.3)	3 (2.1)	4 (1.0)
	Abdominal pain upper	3 (1.9)	2 (1.4)	4 (1.0)
	Abdominal pain	3 (1.9)	1 (0.7)	6 (1.5)
	Flatulence	3 (1.9)	1 (0.7)	5 (1.3)
	Vomiting	5 (3.1)	1 (0.7)	5 (1.3)
	Constipation	2 (1.3)	0	2 (0.5)
General disorders and administration site conditions	Fatigue	4 (2.5)	1 (0.7)	3 (0.8)
Infections and infestations	Clostridium colitis	0	2 (1.4)	2 (0.5)
Metabolism and nutrition disorders	Decreased appetite	2 (1.3)	0	0
Musculoskeletal and connective tissue disorders	Muscle spasms	2 (1.3)	5 (3.6)	6 (1.5)
Nervous system disorders	Dizziness	2 (1.3)	3 (2.1)	8 (2.0)
	Balance disorder	0	2 (1.4)	2 (0.5)
	Headache	5 (3.1)	2 (1.4)	2 (0.5)
	Hepatic encephalopathy	3 (1.9)	2 (1.4)	2 (0.5)
Psychiatric disorders	Insomnia	2 (1.3)	0	1 (0.3)
Skin and subcutaneous tissue disorders	Pruritus	3 (1.9)	2 (1.4)	2 (0.5)

MedDRA System Organ Class Preferred Term	Event	RFHE3001		RFHE3001 and RFHE3002
		Placebo (N = 159)	Rifaximin 550 mg BID (N = 140)	All Rifaximin 550 mg BID (N = 392)
		n (%)	n (%)	n (%)
	Rash	2 (1.3)	1 (0.7)	2 (0.5)

TEAE = treatment-emergent adverse event

Less Common Clinical Trial Adverse Drug Reactions (<1%)

The following adverse reactions, presented by body system, have also been reported (from the placebo-controlled clinical trial RFHE3001 and the long term study RFHE3002) in <1% of patients taking ZAXINE 550 mg taken orally two times a day for hepatic encephalopathy. The following includes adverse events, considered by the investigator to be drug-related:

Blood and lymphatic system disorders: Anaemia, coagulopathy

Ear and labyrinth disorders: Hypoacusis, tinnitus

Eye disorders: Conjunctivitis, visual acuity reduced

Gastrointestinal disorders: Abdominal pain, ascites, constipation, dyspepsia, dry mouth, faeces discoloured, stomach discomfort

General disorders and Administration Site Conditions: Asthenia, fatigue, oedema peripheral, pyrexia

Infections and Infestations: Infectious mononucleosis, Klebsiella bacteraemia, peritonitis bacterial

Injury, Poisoning and Procedural Complications: Fall

Metabolism and nutrition disorders: Anorexia, hypokalemia

Musculoskeletal, Connective Tissue, and Bone disorders: Back pain

Nervous System disorders: Amnesia, balance disorder, headache, hypogeusia, hyposmia

Psychiatric disorders: Anxiety, confusional state, disorientation, insomnia, mental status changes

Renal and urinary disorders: Dysuria

Skin and Subcutaneous Tissue disorders: Pruritus, rash, rash erythematous, swelling face, urticaria

Vascular disorders: Hot flush

Irritable Bowel Syndrome with Diarrhea

The safety of ZAXINE for the treatment of IBS-D was evaluated in 3 placebo-controlled studies in which 952 patients were randomized to ZAXINE 550 mg three times a day for 14 days.

Across the 3 studies, 96% of patients received at least 14 days of treatment with ZAXINE. In Trials 1 and 2, 624 patients received only one 14-day treatment. Trial 3 evaluated the safety of ZAXINE in 328 patients who received 1 open-label treatment and 2 double-blind repeat treatments of 14 days each over a period of up to 46 weeks. The combined population studied had a mean age of 47 (range: 18 to 88) years of whom approximately 11% of the patients were > 65 years old, 72% were female, 88% were White, 9% were Black and 12% were Hispanic.

The adverse reaction that occurred at a frequency $\geq 2\%$ in ZAXINE-treated patients at a higher rate than placebo in Trials 1 and 2 for IBS-D was:

- nausea (ZAXINE 3%, placebo 2%)

The adverse reactions that occurred at a frequency $> 2\%$ in ZAXINE-treated patients (n=328) at a higher rate than placebo (n=308) in Trial 3 for IBS-D during the double-blind treatment phase were:

- ALT increased (ZAXINE 2%, placebo 1%)
- nausea (ZAXINE 2%, placebo 1%)

Table 3 includes the TEAEs occurring in at least 1% of Rifaximin-treated subjects in the Phase 3 studies TARGET 3 and TARGET 1/TARGET 2; Safety Populations.

Table 3: Phase 3 Studies - TEAEs Occurring in at Least 1% of Rifaximin-Treated Subjects (TARGET 3 and TARGET 1/TARGET 2; Safety Populations)

Preferred Term	TARGET 3 Open-Label [1]				TARGET 3 Double-Blind [1]		TARGET 1/TARGET 2	
	OL (Only) Rifaximin 500 mg TID (N=1943) n (%)	DB Rifaximin 500 mg TID (N=328) n (%) [2]	DB Placebo (N=308) n (%) [2]	Total OL Rifaximin 500 mg TID (N=2579) n (%)	Rifaximin in 500 mg TID (N=328) n (%)	Placebo (N=308) n (%)	Rifaximin 500 mg TID (N=624) n (%)	Placebo (N=634) n (%)
Treatment Period (During Treatment with Study Drug)								
Headache	21 (1.1)	3 (0.9)	5 (1.6)	29 (1.1)	2 (0.6)	5 (1.6)	25 (4.0)	28 (4.4)
Abdominal pain	12 (0.6)	2 (0.6)	3 (1.0)	17 (0.7)	1 (0.3)	2 (0.6)	17 (2.7)	17 (2.7)
Nausea	27 (1.4)	5 (1.5)	6 (1.9)	38 (1.5)	6 (1.8)	4 (1.3)	16 (2.6)	12 (1.9)
Diarrhoea	7 (0.4)	0	0	7 (0.3)	4 (1.2)	2 (0.6)	9 (1.4)	8 (1.3)
Flatulence	8 (0.4)	2 (0.6)	2 (0.6)	12 (0.5)	1 (0.3)	0	9 (1.4)	10 (1.6)
Abdominal distension	3 (0.2)	1 (0.3)	1 (0.3)	5 (0.2)	1 (0.3)	0	7 (1.1)	3 (0.5)
Nasopharyngitis	9 (0.5)	0	3 (1.0)	12 (0.5)	4 (1.2)	4 (1.3)	4 (0.6)	18 (2.8)
Alanine aminotransferase increased	14 (0.7)	2 (0.6)	1 (0.3)	17 (0.7)	7 (2.1)	3 (1.0)	0	4 (0.6)
Aspartate aminotransferase increased	15 (0.8)	2 (0.6)	0	17 (0.7)	5 (1.5)	2 (0.6)	0	2 (0.3)

Preferred Term	TARGET 3 Open-Label [1]				TARGET 3 Double-Blind [1]		TARGET 1/ TARGET 2	
	OL (Only) Rifaximin 500 mg TID (N=1943) n (%)	DB Rifaximin 500 mg TID (N=328) n (%) [2]	DB Placebo (N=308) n (%) [2]	Total OL Rifaximin 550 mg TID (N=2579) n (%)	Rifaximin 500 mg TID (N=328) n (%)	Placebo (N=308) n (%)	Rifaximin 500 mg TID (N=624) n (%)	Placebo (N=634) n (%)
Blood creatine phosphokinase increased	17 (0.9)	3 (0.9)	2 (0.6)	22 (0.9)	4 (1.2)	2 (0.6)	0	0
Clostridium test positive	25 (1.3)	0	0	25 (1.0)	0	0	0	0
Overall Evaluation Period (During Treatment with Study Drug + Off-Treatment Intervals [Follow-Up + Maintenance])								
Headache	28 (1.4)	7 (2.1)	7 (2.3)	42 (1.6)	4 (1.2)	9 (2.9)	38 (6.1)	42 (6.6)
Upper respiratory tract infection	29 (1.5)	8 (2.4)	4 (1.3)	41 (1.6)	12 (3.7)	8 (2.6)	35 (5.6)	39 (6.2)
Abdominal pain	26 (1.3)	2 (0.6)	4 (1.3)	32 (1.2)	3 (0.9)	2 (0.6)	29 (4.6)	35 (5.5)
Diarrhoea	20 (1.0)	0	0	20 (0.8)	7 (2.1)	3 (1.0)	27 (4.3)	22 (3.5)
Nausea	35 (1.8)	8 (2.4)	9 (2.9)	52 (2.0)	12 (3.7)	7 (2.3)	27 (4.3)	24 (3.8)
Nasopharyngitis	29 (1.5)	3 (0.9)	4 (1.3)	36 (1.4)	10 (3.0)	9 (2.9)	19 (3.0)	34 (5.4)
Sinusitis	21 (1.1)	5 (1.5)	8 (2.6)	34 (1.3)	7 (2.1)	7 (2.3)	17 (2.7)	16 (2.5)
Vomiting	13 (0.7)	4 (1.2)	7 (2.3)	24 (0.9)	2 (0.6)	5 (1.6)	15 (2.4)	9 (1.4)
Bronchitis	12 (0.6)	1 (0.3)	2 (0.6)	15 (0.6)	9 (2.7)	5 (1.6)	13 (2.1)	17 (2.7)
Cough	7 (0.4)	4 (1.2)	2 (0.6)	13 (0.5)	3 (0.9)	5 (1.6)	13 (2.1)	9 (1.4)
Urinary tract infection	25 (1.3)	4 (1.2)	6 (1.9)	35 (1.4)	11 (3.4)	15 (4.9)	12 (1.9)	11 (1.7)
Abdominal distension	5 (0.3)	1 (0.3)	1 (0.3)	7 (0.3)	2 (0.6)	0	11 (1.8)	10 (1.6)
Back pain	11 (0.6)	1 (0.3)	2 (0.6)	14 (0.5)	5 (1.5)	5 (1.6)	10 (1.6)	15 (2.4)
Flatulence	8 (0.4)	2 (0.6)	2 (0.6)	12 (0.5)	1 (0.3)	0	10 (1.6)	14 (2.2)
Dyspepsia	6 (0.3)	3 (0.9)	2 (0.6)	11 (0.4)	1 (0.3)	1 (0.3)	9 (1.4)	8 (1.3)
Influenza	17 (0.9)	12 (3.7)	4 (1.3)	33 (1.3)	7 (2.1)	2 (0.6)	9 (1.4)	9 (1.4)
Pharyngolaryngeal pain	0	0	0	0	0	0	9 (1.4)	15 (2.4)
Vulvovaginal mycotic infection	7 (0.4)	2 (0.6)	4 (1.3)	13 (0.5)	1 (0.3)	0	8 (1.3)	7 (1.1)

Preferred Term	TARGET 3 Open-Label [1]				TARGET 3 Double-Blind [1]		TARGET 1/TARGET 2	
	OL (Only) Rifaximin 500 mg TID (N=1943) n (%)	DB Rifaximin 500 mg TID (N=328) n (%) [2]	DB Placebo (N=308) n (%) [2]	Total OL Rifaximin 550 mg TID (N=2579) n (%)	Rifaximin 500 mg TID (N=328) n (%)	Placebo (N=308) n (%)	Rifaximin 500 mg TID (N=624) n (%)	Placebo (N=634) n (%)
Abdominal tenderness	6 (0.3)	1 (0.3)	0	7 (0.3)	1 (0.3)	0	7 (1.1)	7 (1.1)
Dizziness	12 (0.6)	3 (0.9)	2 (0.6)	17 (0.7)	3 (0.9)	2 (0.6)	7 (1.1)	8 (1.3)
Gastroenteritis viral	11 (0.6)	2 (0.6)	1 (0.3)	14 (0.5)	4 (1.2)	3 (1.0)	7 (1.1)	8 (1.3)
Migraine	2 (0.1)	0	3 (1.0)	5 (0.2)	0	1 (0.3)	7 (1.1)	3 (0.5)
Nasal congestion	2 (0.1)	0	3 (1.0)	5 (0.2)	0	3 (1.0)	7 (1.1)	3 (0.5)
Tooth abscess	0	0	0	0	1 (0.3)	1 (0.3)	7 (1.1)	3 (0.5)
Alanine aminotransferase increased	20 (1.0)	3 (0.9)	1 (0.3)	24 (0.9)	9 (2.7)	4 (1.3)	6 (1.0)	7 (1.1)
Aspartate aminotransferase increased	22 (1.1)	2 (0.6)	0	24 (0.9)	7 (2.1)	4 (1.3)	5 (0.8)	5 (0.8)
Arthralgia	10 (0.5)	5 (1.5)	2 (0.6)	17 (0.7)	3 (0.9)	8 (2.6)	4 (0.6)	4 (0.6)
Gamma-glutamyltransferase increased	14 (0.7)	2 (0.6)	0	16 (0.6)	5 (1.5)	1 (0.3)	4 (0.6)	3 (0.5)
Hypertension	9 (0.5)	2 (0.6)	1 (0.3)	12 (0.5)	5 (1.5)	4 (1.3)	4 (0.6)	3 (0.5)
Muscle strain	6 (0.3)	4 (1.2)	1 (0.3)	11 (0.4)	1 (0.3)	1 (0.3)	3 (0.5)	1 (0.2)

^a All 2579 subjects in the open-label Treatment Phase 2 of TARGET 3 received rifaximin: 1943 of these subjects participated only in the Treatment Phase 2, while 636 subjects went on to be randomized in DBR Treatment Phase 3 and subsequently to participate in the repeat-treatment phases, that is, DBR Treatment Phase 3 and SRT Treatment Phase 4. Open label includes Treatment Phase 2 and Maintenance Phase 1. Double-blind includes Treatment Phases 3 (DBR) and 4 (SRT) including follow-up periods, Maintenance Phase 2, and the final 4-week follow up. Treatment Period includes only the 14-day treatment period, whereas Overall Evaluation Period includes all treatment, follow up, and maintenance periods.

^b These columns provide TEAEs during the OL experienced by subjects eventually randomized to the DB period.

Abnormal Hematologic and Clinical Chemistry Findings

In TARGET 1, TARGET 2, and TARGET 3, abnormal clinical laboratory test results that were considered by the investigator to be clinically significant were to be recorded as adverse events. ALT, AST, and CPK increases were reported as adverse events with similar frequency during the treatment period for ZAXINE and placebo in TARGET 1 and TARGET 2. For the double-blind

treatment period of TARGET 3, frequencies of ALT, AST, and CPK increase adverse events for ZAXINE and placebo were 2.1% versus 1.0%, 1.5% versus 0.6%, and 1.2% versus 0.6%, respectively. Thrombocytopenia was not reported in TARGET 1, TARGET 2, or in the double-blind phase of TARGET 3. Thrombocytopenia was reported in 2 subjects in the open-label phase of TARGET 3; both resolved on continued treatment with ZAXINE. Anemia was reported in 2 placebo subjects in TARGET 2, and in no subject in TARGET 1 or in the double-blind phase of TARGET 3. In the open-label phase of TARGET 3, anemia was reported in 3 subjects and macrocytic anemia was reported in 1 subject treated with ZAXINE; none of the adverse events were considered related to treatment.

Post-Market Adverse Drug Reactions

The following adverse reactions have been identified during post approval use of ZAXINE. Because these reactions are reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These reactions have been chosen for inclusion due to either their seriousness, frequency of reporting or causal connection to ZAXINE.

Infections and Infestation: *C. difficile*-associated colitis

General: Hypersensitivity reactions, including exfoliative dermatitis, rash, angioneurotic edema (swelling of face and tongue and difficulty swallowing), urticaria, flushing, pruritus and anaphylaxis have been reported. These events occurred as early as within 15 minutes of drug administration.

DRUG INTERACTIONS

Overview

Rifaximin is a structural analog of rifampin, a rifamycin derivative. ZAXINE contains rifaximin- α , one of the polymorphic forms of rifaximin. Low systemic absorption of this alfa form has been noted in healthy individuals, but absorption is increased in subjects with impaired hepatic function, and to a lesser extent, in patients with inflammatory bowel disease and irritable bowel syndrome.

In Vitro Data

In vitro studies in human hepatocytes have demonstrated:

- Rifaximin is metabolized by CYP3A4.
- Rifaximin is a weak inducer of CYP3A4 (at a concentration of 0.2 μ M [157 ng/ml]).
- Rifaximin did not inhibit cytochrome P450 isoenzymes 1A2, 2A6, 2B6, 2C9, 2C19, 2D6, 2E1 and CYP3A4 at concentrations ranging up from 2 to 200 ng/mL.

An *in vitro* study suggested that rifaximin is a substrate of, and a weak inhibitor of P-glycoprotein (P-gp) (See **DETAILED PHARMACOLOGY**).

Drug-Drug Interactions

Error! Reference source not found. summarizes the potential for drug-drug interactions with rifaximin.

Table 4: Established or Potential Drug-Drug Interactions for Rifaximin

Proper name	Reference	Effect	Clinical comment
CYP3A4 substrates (e.g. Midazolam)	CT	Rifaximin 550 mg bid x 7 or 14 days reduced oral midazolam AUC by 4 – 9%, and C _{max} by 4-5% in healthy subjects	Rifaximin is a substrate and a weak inducer of CYP3A4 <i>in vitro</i> . No clinically significant effects on the pharmacokinetics of CYP3A4 substrates were found in healthy subjects; however, the effect of rifaximin on CYP3A4 substrates in subjects with hepatic impairment has not been evaluated. The drug could have an effect on the pharmacokinetics of concomitant CYP3A4 substrates (eg. warfarin, antiepileptics, antiarrhythmics) in hepatically impaired subjects who have elevated systemic levels of rifaximin.
P-gp inhibitors (e.g. Cyclosporine)	CT	Cyclosporine 600 mg increased C _{max} of rifaximin 83-fold and increased AUC 124-fold in healthy subjects	Concomitant drugs that inhibit P-gp could significantly increase the systemic exposure of rifaximin in hepatically impaired subjects, in particular in patients with severe hepatic impairment
P-gp substrates (e.g. Digoxin)	T	Rifaximin showed weak inhibition of digoxin transport <i>in vitro</i> at concentrations 100 times clinical C _{max} in healthy subjects	Clinical relevance in hepatically impaired subjects is unknown
Oral Contraceptives - CYP3A4 substrate and potential for rifaximin-induced altered gut flora effect (e.g. ethinyl estradiol and norgestimate)	CT	After rifaximin 550 mg TID x 7 days in healthy volunteers, C _{max} of OC minimally lowered, but no change in AUC of OC.	OC C _{max} within clinically reported values. Clinical relevance of minimal C _{max} reduction in healthy volunteers and effects on contraception are unknown.
Warfarin	Case Study	A patient on rifaximin 400 mg TID x 10 days for small intestinal bacterial overgrowth, also on a stable warfarin dose, had elevated INR while on rifaximin.	Patient was on stable warfarin therapy, and when given rifaximin treatment for small intestinal bacterial overgrowth, anticoagulation was attenuated. This potential interaction has not been studied in a controlled clinical trial.

CT = Clinical Trial; T = Theoretical

Drug-Food Interactions

In healthy volunteers, administration of rifaximin within 30 minutes of a standardized high-fat breakfast increased C_{max} and AUC by approximately 1.2- and 2-fold, respectively.

Drug-Herb Interactions

Interactions with herbal products have not been established.

Drug-Laboratory Interactions

Interactions with laboratory tests have not been established.

DOSAGE AND ADMINISTRATION

Dosing Considerations

Due to the limited systemic absorption of ZAXINE (rifaximin), no specific dosing adjustment is recommended for patients with mild to moderate hepatic insufficiency.

Although no dosage adjustment is recommended at this time, caution should be exercised when ZAXINE is administered to patients with severe (Child-Pugh C) hepatic impairment and in patients with MELD score ≥ 25 (see **ACTION AND CLINICAL PHARMACOLOGY, Pharmacokinetics**). While taking ZAXINE with food has resulted in small increases in systemic exposure in healthy subjects, the effects of food on ZAXINE exposure in hepatic impairment patients have not been studied. However, since the absolute systemic bioavailability of rifaximin is still relatively low and the drug works locally in the gastrointestinal tract, rifaximin can be given with or without food.

Treatment duration beyond 6 months should take into consideration the individual balance between benefits and risks, including those associated with the progression of hepatic dysfunction and increasing systemic exposure to rifaximin.

Recommended Dose and Dosage Adjustment

Hepatic Encephalopathy

The recommended dose of ZAXINE is one 550 mg tablet taken orally two times a day. No more than two doses of ZAXINE (1 tablet twice a day) should be taken in a 24-hour period.

Irritable Bowel Syndrome with Diarrhea

The recommended dose of ZAXINE is one 550 mg tablet taken orally three times a day for 14 days.

In the trials of ZAXINE for IBS-D, patients who experienced a recurrence of symptoms and who responded to a first treatment were safely and effectively retreated for up to 2 times. Current clinical trials have not evaluated the safety and efficacy of three or more repeat treatments for IBS-D.

No more than three doses of ZAXINE (1 tablet three times a day) should be taken in a 24-hour period.

ZAXINE can be taken with or without food (see **ACTION AND CLINICAL PHARMACOLOGY, Pharmacokinetics, Table 7**). Tablets should be swallowed whole.

Missed Dose

If a dose is missed, it should be taken as soon as possible. However, if it is almost time for the next dose, no additional dose should be taken and the regular dosing schedule should be resumed.

OVERDOSAGE

No specific information is available on the treatment of overdose with ZAXINE (rifaximin). In clinical studies at doses higher than the recommended dose (i.e., > 1100 mg/day for HE and 1650 mg/day for IBS-D [up to a daily maximum of 2400 mg rifaximin]), adverse reactions were similar in subjects receiving ZAXINE or placebo. In the case of overdose, discontinue ZAXINE, treat symptomatically, and institute supportive measures as required.

For management of a suspected drug overdose, contact your regional Poison Control Centre.

ACTION AND CLINICAL PHARMACOLOGY

Mechanism of Action

Rifaximin is a non-aminoglycoside semi-synthetic antibacterial derived from rifamycin SV. Rifaximin acts by binding to the beta-subunit of bacterial DNA-dependent RNA polymerase resulting in inhibition of bacterial RNA synthesis. Rifaximin has a broad antimicrobial spectrum against many Gram-positive, Gram-negative, aerobic and anaerobic bacteria, including ammonia-producing species. Rifaximin may also be effective against enteric protozoal infections, including *Cryptosporidium* and *Blastocystis*. Rifaximin may also modulate the local gut inflammatory host response through the select activation of the human pregnane X receptor (PXR).

Due to the generally low absorption from the gastro-intestinal tract, rifaximin is locally-acting in the intestinal lumen and clinically not effective against invasive pathogens.

In Hepatic Encephalopathy:

Rifaximin is believed to reduce recurrence of overt hepatic encephalopathy (HE) by decreasing the bacterial toxin load on the liver of cirrhotic. As a result, decreasing the neuroinflammation response to toxins and other bacterial products experienced in the central nervous system that can precipitate HE episodes.

Irritable Bowel Syndrome with Diarrhea:

Microbiota in the GI track are believed to play an important role in the development of these symptoms especially those associated with IBS-D. It has been shown that an acute gastrointestinal infection can increase the odds by six-fold of developing IBS. It is suggested

that a dysbiosis in the microbiome can lead to increased bloating by way of increased fermentation/gas, small intestinal bacterial overgrowth, mucosal irritation and minimal chronic localized inflammation in the gut.

A sustained effect in IBS-D has been observed following a 2-week treatment course with rifaximin. This suggests that rifaximin may affect the underlying causes of IBS-D mediated by bacterial dysbiosis. Rifaximin’s primary mode of action reduces the bacterial load and bacterial products that can negatively affect the host, alleviating the most common symptoms of IBS-D including bloating, abdominal pain and diarrhea. Furthermore, rifaximin’s effect on gut microbiota may reduce the local immune responses and by suppressing the effect of bacterial endotoxins helping to prevent dysbiosis, maintain homeostasis and mucosal integrity. Rifaximin may also modulate the patient’s local immune responses directly via the PXR pathway; it has been shown to reduce and reverse local mucosal inflammation.

Pharmacokinetics

Absorption:

Hepatic Encephalopathy

After a single dose and multiple doses of ZAXINE (rifaximin) 550 mg in healthy subjects, the mean time to reach peak plasma concentrations was about an hour. The pharmacokinetic (PK) parameters were highly variable and the accumulation ratio based on AUC was 1.37. The dosing interval was BID or every 12 hours (Table 5).

The PK of ZAXINE in patients with a history of HE was evaluated after administration of ZAXINE, 550 mg two times a day. The PK parameters were associated with a high variability and mean ZAXINE exposure (AUC_{tau}) in patients with a history of HE (147 ng•h/mL) was approximately 12-fold higher than that observed in healthy subjects following the same dosing regimen (12.3 ng•h/mL). When PK parameters were analyzed based on Child-Pugh Class A, B, and C, the mean AUC_{tau} was 10-, 13-, and 20-fold higher, respectively, compared to that in healthy subjects (Table 5).

Table 6: Mean (± SD) Pharmacokinetic Parameters of ZAXINE at Steady-State in Patients with a History of Hepatic Encephalopathy by Child-Pugh Class¹

Pharmacokinetic Parameter	Healthy Subjects (n=14)	Child-Pugh Class		
		A (n=18)	B (n=15)	C (n=6)
AUC _{tau} (ng•h/mL)	12.3 ± 4.8	118 ± 67.8	169 ± 55.7	257 ± 100
C _{max} (ng/mL)	3.4 ± 1.6	19.5 ± 11.4	25.4 ± 11.9	39.7 ± 13.5
T _{max} ^b (h), range	0.8 (0.5, 4.0)	1 (0.9, 10)	1 (0.97, 4.2)	1 (0, 2)
T _{1/2} (h)	4.2 ± 3.3	8.1 ± 3.6	8.0 ± 2.5	6.4 ± 1.1

¹ Cross-study comparison with PK parameters in healthy subjects

² Median

Irritable Bowel Syndrome with Diarrhea

In patients with irritable bowel syndrome with diarrhea (IBS-D) treated with ZAXINE 550 mg three times a day for 14 days, the median T_{max} was 1 hour and mean C_{max} and AUC were generally comparable with those in healthy subjects. After multiple doses, AUC was 1.65-fold higher than that on Day 1 in IBS-D patients (Table 7).

Table 8: Mean (\pm SD) Pharmacokinetic Parameters of Rifaximin Following ZAXINE 550 mg Three Times a Day in IBS-D Patients and Healthy Subjects

Pharmacokinetic Parameter	Healthy Subjects		IBS-D Patients	
	Single-Dose (Day 1) n=12	Multiple-Dose (Day 14) n=14	Single-Dose (Day 1) n=24	Multiple-Dose (Day 14) n=24
AUC _{tau} (ng•h/mL)	10.4 (3.47)	9.30 (2.7)	9.69 (4.16)	16.0 (9.59)
C_{max} (ng/mL)	4.04 (1.51)	2.39 (1.28)	3.49 (1.36)	4.22 (2.66)
T_{max} (h)*, range	0.75 (0.5-2.1)	1.00 (0.5-2.0)	0.78 (0-2)	1.00 (0.5-2)
$T_{1/2}$ (h)	1.83 (1.38)	5.63 (5.27)	3.14 (1.71)	6.08(1.68)

*Median

Food Effect in Healthy Subjects

A high-fat meal consumed 30 minutes prior to ZAXINE dosing in healthy subjects delayed the mean time to peak plasma concentration from 0.8 to 1.5 hours and increased the systemic exposure (AUC) of ZAXINE by 2-fold (Table 9 **Error! Reference source not found.**).

However, since the absolute systemic bioavailability of rifaximin is still relatively low and the drug works locally in the gastrointestinal tract, rifaximin can be given with or without food.

Table 10: Mean (\pm SD) Pharmacokinetic Parameters after Single-Dose Administration of Rifaximin 550 mg in Healthy Subjects under Fasting and Fed Conditions (N=12)

Rifaximin Parameters	Fasting	Fed
C_{max} (ng/mL)	4.0 \pm 1.5	4.8 \pm 4.3
T_{max} (h) ^a	0.8 (0.5, 2.1)	1.5 (0.5, 4.1)
$t_{1/2}$ (h)	1.8 \pm 1.4	4.8 \pm 1.3
AUC _{0-∞} (ng•h/mL)	11.1 \pm 4.2	22.5 \pm 12

^aMedian and range

Distribution:

Rifaximin is moderately bound to human plasma proteins. *In vivo*, the mean protein binding ratio was 67.5% in healthy subjects and 62% in patients with hepatic impairment when ZAXINE 550 mg was administered.

Metabolism and Excretion:

In vitro studies in human liver cell lines suggested that rifaximin is metabolized by CYP3A4. (See **DETAILED PHARMACOLOGY, HUMAN PHARMACOLOGY.**)

Rifaximin is almost exclusively excreted in faeces. In a mass balance study, after administration of 400 mg ¹⁴C-rifaximin orally to healthy subjects, of the 96.94% total recovery, 96.62% of the

administered radioactivity was recovered in faeces almost exclusively as the unchanged drug and 0.32% was recovered in urine mostly as metabolites with 0.03% as the unchanged drug. This suggests that the absorbed rifaximin undergoes metabolism with minimal renal excretion of the unchanged drug. Rifaximin was detected in the bile after cholecystectomy in patients with intact gastrointestinal mucosa, indicating some biliary excretion of systemically absorbed rifaximin.

Special Populations and Conditions

Hepatic Insufficiency: The systemic exposure of rifaximin was elevated in patients with hepatic impairment compared to healthy subjects. When PK parameters were analyzed based on Child-Pugh Class A, B, and C, the mean AUC_τ was 10-, 13-, and 20-fold higher, respectively, compared to that in healthy subjects. (See **ACTION AND CLINICAL PHARMACOLOGY, Pharmacokinetics, Table 5.**)

Renal Insufficiency: The pharmacokinetics of rifaximin in patients with impaired renal function have not been studied.

STORAGE AND STABILITY

Store ZAXINE (rifaximin) tablets at 20–25°C (68–77°F); excursions permitted to 15–30°C (59–86°F). Store in a tightly closed container away from heat and direct light.

DOSAGE FORMS, COMPOSITION AND PACKAGING

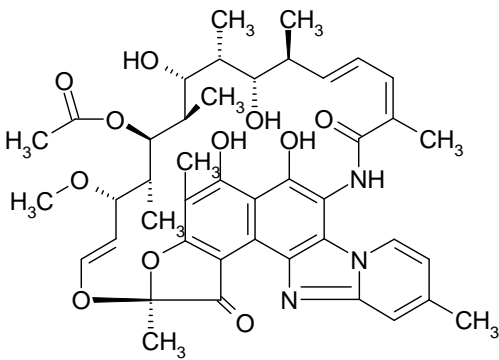
ZAXINE (rifaximin) 550 mg is a pink, oval, biconvex tablet with “rfx” debossed on one side. It is available in bottles of 60 tablets.

Non-medicinal ingredients: colloidal silicon dioxide, glyceryl distearate, microcrystalline cellulose, polyethylene glycol, polyvinyl alcohol, red iron oxide, gluten-free sodium starch glycolate, talc, and titanium dioxide.

PART II: SCIENTIFIC INFORMATION

PHARMACEUTICAL INFORMATION

Drug Substance

Proper name:	Rifaximin
Chemical name:	(2 <i>S</i> ,16 <i>Z</i> ,18 <i>E</i> ,20 <i>S</i> ,21 <i>S</i> ,22 <i>R</i> ,23 <i>R</i> ,24 <i>R</i> ,25 <i>S</i> ,26 <i>S</i> ,27 <i>S</i> ,28 <i>E</i>)-5,6,21,23,25-pentahydroxy-27-methoxy-2,4,11,16,20,22,24,26-octamethyl-2,7-(epoxypentadeca[1,11,13]trienimino)benzofuro[4,5- <i>e</i>]pyrido[1,2- <i>α</i>]-benzimidazole-1,15(2 <i>H</i>)-dione,25-acetate
Molecular formula and molecular mass:	C ₄₃ H ₅₁ N ₃ O ₁₁ MW=785.9
Structural formula:	

Physicochemical properties: Rifaximin is red/orange microcrystalline powder, soluble in methanol, chloroform, acetone and ethyl acetate. It is practically insoluble in water. It has a pK_a of 6.77. The partition co-efficient (*n*-octanol-water) is 2.76.

CLINICAL TRIALS

Hepatic Encephalopathy

The safety and efficacy of ZAXINE (rifaximin) 550 mg twice daily in adult patients in remission from overt HE was assessed in one randomized double-blind, parallel group, controlled multicentre six-month trial, and in one multicentre, open-label, long term study. Study demographics and trial design are summarized in [Table 8](#).

Table 11: Summary of Patient Demographics for Clinical Trials in Prevention of Overt HE Recurrence in Patients ≥18 Years of Age

Study #	Trial design	Dosage, route of administration and duration	Study subjects (N = number)	Mean age (Range)	Gender
RFHE3001 (Pivotal - Safety and Efficacy)	Randomized placebo controlled, double-blind, multicentre (US, Canada, Russia)	550 mg BID, oral, up to 6 months Placebo BID, up to 6 months	N = 299 Rifaximin = 140 Placebo = 159	56 years (21-82 years)	61% male
RFHE3002 (Safety)	Open-label, multicentre (US, Canada, Russia), treatment extension study	550 mg BID, oral at least 24 months	N = 322 rifaximin subjects (152 from study 3001 [70 rifaximin and 82 placebo] and 170 new subjects)	57 years (21-82 years)	61 % male

More than 90% of the subjects in both studies received concomitant lactulose. No patients were enrolled with a MELD score >25.

Study Results RFHE3001:

The primary efficacy endpoint was the time to first breakthrough overt HE episode. Patients were withdrawn after a breakthrough overt HE episode.

Breakthrough overt HE episodes were experienced by 31 of 140 subjects (22%) in the ZAXINE group and by 73 of 159 subjects (46%) in the placebo group during the 6-month treatment period. ZAXINE significantly reduced the risk of overt HE breakthrough by 58% ($p < 0.0001$) during the 6-month treatment period.

A key secondary endpoint included time to first HE-related hospitalization. HE-related hospitalizations (hospitalizations directly resulting from HE, or hospitalizations complicated by HE) were reported for 19 of 140 subjects (14%) and 36 of 159 subjects (23%) in the ZAXINE and placebo groups, respectively. ZAXINE significantly reduced the risk of overt HE-related hospitalizations by 50% ($p < 0.0129$) during the 6-month treatment period (see [Table 9](#)).

Study Results RFHE3002:

In this open-label, uncontrolled study, treatment with ZAXINE for periods up to 24 months did not result in any loss of effect regarding protection from breakthrough overt HE episodes and the reduction in the burden of hospitalization. The time to first breakthrough overt HE episode profiles demonstrated long-term maintenance of remission in new ZAXINE subjects in RFHE3002 (including placebo crossover subjects from RFHE3001) and continuing ZAXINE subjects in RFHE3002 (i.e., ZAXINE rollover subjects from RFHE3001) (see [Table 11](#)).

Table 12: Rates of HE-Related and All-Cause Hospitalizations

Hospitalization Rates	Historical Placebo (RFHE3001) n=159	Historical Rifaximin (RFHE3001) n=140	New Rifaximin (RFHE3002) n=252	All Rifaximin (RFHE3001 + RFHE3002) n=392
HE related Hospitalization rates (events/PYE)	0.72	0.30*	0.23	0.21
All – Cause Hospitalization rates (events/PYE)	1.30	0.92	0.44	0.45

Rates of HE-related and all-cause hospitalizations for the all-rifaximin and new-rifaximin populations in the OLM compared with patients receiving historical placebo or rifaximin in the 6-month RCT (RFHE3001). *p < 0.0001 vs placebo. The integrated all-rifaximin population includes 70 from the treatment group in RFHE3001, 70 from treatment group in RFHE3001 that transitioned to RFHE3002, 82 from the placebo group that transitioned to receive rifaximin in RFHE3002 and 170 new patients enrolled in RFHE3002.

Irritable Bowel Syndrome with Diarrhea

The efficacy of ZAXINE (rifaximin) 550 mg for the treatment of IBS-D was established in 3 randomized, multicenter, double-blind, placebo-controlled trials in adult patients.

TARGET 1 and TARGET 2 Design

The first two trials, TARGET 1 and TARGET 2 were of identical design. In these trials, a total of 1258 patients meeting Rome II criteria for IBS* were randomized to receive ZAXINE 550 mg three times a day (n=624) or placebo (n=634) for 14 days and then followed for a 10-week treatment-free period. The Rome II criteria further categorizes IBS patients into 3 subtypes: diarrhea-predominant IBS (IBS-D), constipation-predominant IBS (IBS-C), or alternating IBS (bowel habits alternating between diarrhea and constipation). Patients with both IBS-D and alternating IBS were included in TARGET 1 and TARGET 2. ZAXINE is recommended for use in patients with IBS-D.

*Rome II Criteria: At least 12 weeks, which need not be consecutive, in the preceding 12 months of abdominal discomfort or pain that has two out of three features: 1. Relieved with defecation; and/or 2. Onset associated with a change in frequency of stool; and/or 3. Onset associated with a change in form (appearance) of stool.

Symptoms that Cumulatively Support the Diagnosis of Irritable Bowel Syndrome

Abnormal stool frequency (for research purposes “abnormal” may be defined as greater than 3 bowel movements per day and less than 3 bowel movements per week); Abnormal stool form (lumpy/hard or loose/watery stool); Abnormal stool passage (straining, urgency, or feeling of incomplete evacuation); Passage of mucus; Bloating or feeling of abdominal distension.

Study Results TARGET 1 and TARGET 2:

TARGET 1 and TARGET 2 included 1,258 IBS-D patients (309 ZAXINE, 314 placebo) and (315 ZAXINE, 320 placebo). The primary endpoint for both trials was the proportion of patients who achieved adequate relief of IBS signs and symptoms for at least 2 of 4 weeks during the month following 14 days of treatment. Adequate relief was defined as a response of “yes” to the following weekly Subject Global Assessment (SGA) question: “In regards to your IBS symptoms, compared to the way you felt before you started study medication, have you, in the past 7 days, had adequate relief of your IBS symptoms? [Yes/No].”

Adequate relief of IBS symptoms was experienced by more patients receiving ZAXINE than those receiving placebo during the month following 2 weeks of treatment (SGA-IBS Weekly Results: 41% vs. 31%, p=0.0125; 41% vs. 32%, p=0.0263 (See [Table 10](#)).

Table 13: Adequate Relief of IBS Symptoms during the Month Following Two Weeks of Treatment

Endpoint	TARGET 1			TARGET 2		
	ZAXINE n=309 n (%)	Placebo n=314 n (%)	Treatment Difference (95% CI ^a)	ZAXINE n=315 n (%)	Placebo n=320 n (%)	Treatment Difference (95% CI ^a)
Adequate Relief of IBS Symptoms ^b	126 (41)	98 (31)	10% (2.1%, 17.1%)	128 (41)	103 (32)	8% (1.0%, 15.9%)

^a Confidence Interval

^b The p-value for the primary endpoint for TARGET 1 and for TARGET 2 was < 0.05

The trials examined a composite endpoint which defined responders by IBS-related abdominal pain *and* stool consistency measures. Patients were monthly responders if they met both of the following criteria:

- experienced a $\geq 30\%$ decrease from baseline in abdominal pain for ≥ 2 weeks during the month following 2 weeks of treatment
- had a weekly mean stool consistency score < 4 (loose stool) for ≥ 2 weeks during the month following 2 weeks of treatment

More patients receiving ZAXINE were monthly responders for abdominal pain *and* stool consistency in TARGET 1 and 2 (see [Table 11](#)).

Table 14: Efficacy Responder Rates in TARGET 1 and 2 during the Month Following Two Weeks of Treatment

Endpoint	TARGET 1			TARGET 2		
	ZAXINE n=309 n (%)	Placebo n=314 n (%)	Treatment Difference (95% CI ^a)	ZAXINE n=315 n (%)	Placebo n=320 n (%)	Treatment Difference (95% CI ^a)
Abdominal Pain and Stool Consistency Responders ^b	144 (47)	121 (39)	8% (0.3%, 15.9%)	147 (47)	116 (36)	11% (2.7%, 18.0%)
Abdominal Pain Responders ^c	159 (51)	132 (42)	9% (1.8%, 17.5%)	165 (52)	138 (43)	9% (1.5%, 17.0%)
Stool Consistency Responders ^d	244 (79)	212 (68)	11% (4.4%, 18.2%)	233 (74)	206 (64)	10% (2.3%, 16.7%)

^a Confidence Interval

^b The p-value for the composite endpoint for TARGET 1 and for TARGET 2 was < 0.05 and < 0.01, respectively

^c The p-value for TARGET 1 and for TARGET 2 was < 0.02

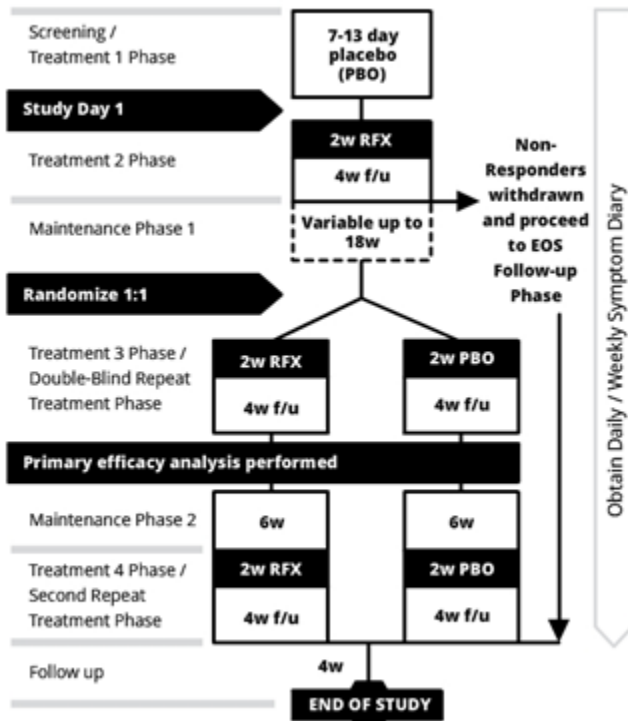
^d The p-value for TARGET 1 and for TARGET 2 was < 0.01

The safety profile during and after treatment with rifaximin 550 mg TID for 14 days was comparable to that observed with placebo in both studies. A similar proportion of rifaximin-treated subjects and placebo-treated subjects (55% vs 55% in TARGET 1 and 54 vs 52% in TARGET 2, respectively) experienced TEAEs (Treatment-emergent adverse event) during this study.

TARGET 3 – Study Design

TARGET 3 evaluated repeat treatment in adults with IBS-D meeting Rome III criteria** for up to 46 weeks. A total of 2579 were enrolled to receive open-label ZAXINE for 14 days. Of the 2438 evaluable patients, 1074 (44%) responded to initial treatment and were evaluated over 22 weeks for continued response or recurrence of IBS-symptoms. A total of 636 patients had symptom recurrence and were randomized into the double-blind phase of the study. These patients were scheduled to receive ZAXINE 550 mg three times a day (n=328) or placebo (n=308) for two additional 14-day repeat treatment courses separated by 10 weeks, see [Error! Reference source not found.](#)

Figure 1: Target 3 Study Design



**Rome III Criteria: Recurrent abdominal pain or discomfort (uncomfortable sensation not described as pain) at least 3 days/month in last 3 months associated with two or more of the following: 1) improvement with defecation; 2) onset associated with a change in frequency of stool; 3) onset associated with a change in form (appearance) of stool.

Demographics:

The IBS-D population from the three studies (TARGET 1, 2 and 3) had mean age of 47 (range: 18 to 88) years of which approximately 11% of patients were ≥ 65 years old, 72% were female and 88% were white.

Study Results TARGET 3:

In TARGET 3, 2,579 patients were scheduled to receive an initial 14-day course of open-label ZAXINE followed by 4 weeks of treatment-free follow-up. At the end of the follow-up period, patients were assessed for response to treatment. Patients were considered responders if they simultaneously met the weekly response criteria during ≥ 2 of the 4 weeks after treatment for the following:

- $\geq 30\%$ improvement from baseline in the weekly average abdominal pain score based on the daily question: *“In regards to your specific IBS symptoms of abdominal pain, on a scale of 0-10, what was your worst IBS-related abdominal pain over the last 24 hours? ‘Zero’ means you have no pain at all; ‘Ten’ means the worst possible pain you can imagine”.*

- at least a 50% reduction in the number of days in a week with a daily stool consistency of Bristol Stool Scale Type 6 or 7 compared with baseline where 6=fluffy pieces with ragged edges, a mushy stool; 7=watery stool, no solid pieces; entirely liquid.

Responders were then followed for recurrence of their IBS-related symptoms of abdominal pain *or* mushy/watery stool consistency for up to 20 treatment-free weeks.

When patients experienced recurrence of their symptoms of abdominal pain *or* mushy/watery stool consistency for 3 weeks of a rolling 4-week period, they were randomized into the double-blind, placebo-controlled repeat treatment phase. Of the 1,074 patients who responded to open-label ZAXINE, 382 experienced a period of symptom inactivity or decrease that did not require repeat treatment by the time they discontinued, including patients who completed the 22 weeks after initial treatment with ZAXINE (see **Error! Reference source not found.**).

Overall, 1,257 of 2,579 patients (49%) were non-responders in the open-label phase and per the study protocol were withdrawn from the study. Other reasons for discontinuation include: patient request (5%), patient lost to follow-up (4%), adverse reaction (3%), and other (0.8%).

There were 1,074 (44%) of 2,438 evaluable patients who responded to initial treatment with improvement in abdominal pain *and* stool consistency. The response rate during the open-label phase for TARGET 3 assessed as a 30% improvement in abdominal pain and an improvement in stool consistency is found to be similar to the rates seen in earlier studies (TARGET 1 and 2) even though a slight difference in responder definitions exists between the studies (see [Table 11](#)).

A total of 636 patients subsequently had sign and symptom recurrence and were randomized to the repeat treatment phase. The median time to recurrence for patients who experienced initial response during the open-label phase with ZAXINE was 10 weeks (range 6 to 24 weeks).

The ZAXINE and placebo treatment groups had similar baseline IBS symptom scores at the time of recurrence and randomization to the double-blind phase, but symptom scores were less severe than at study entry into the open-label phase.

Patients were deemed to have recurrent signs and symptoms by the following criteria: a return of abdominal pain or lack of stool consistency for at least 3 weeks during a 4-week follow-up period. The primary endpoint in the double-blind, placebo-controlled portion of the trial was the proportion of patients who were responders to repeat treatment in both IBS-related abdominal pain *and* stool consistency as defined above during the 4 weeks following the first repeat treatment with ZAXINE. The primary analysis was performed using the worst case analysis method where patients with < 4 days of diary entries in a given week are considered as non-responders for that week.

More patients receiving ZAXINE were monthly responders for abdominal pain *and* stool consistency in the primary analysis in TARGET 3 (see [Table 12](#)).

Table 15: Efficacy Responder Rates in TARGET 3 in a Given Week for at Least 2 Weeks during Weeks 3 to 6 of the Double Blind, First Repeat Treatment Phase (Worst Case Analysis)

Type of Responder	Placebo (n=308) n (%)	ZAXINE (n=328) n (%)	Treatment Difference (95% CI ^a)
Combined Responder ^b : Abdominal Pain and Stool Consistency Responders	77 (25)	107 (33)	8% (0.6%, 14.6%)
Abdominal Pain Responders ^d (≥ 30% reduction in abdominal pain)	130 (42)	166 (51)	8% (0.7%, 16.1%)
Stool Consistency Responders (≥ 50% reduction from baseline in days/week with loose or watery stools)	111 (36)	138 (42)	6% (-1.5%, 13.6%)

^a Confidence Intervals were derived based on CMH test adjusting for center and patients' time to recurrence during maintenance phase.

^b Primary endpoint

^c Subjects were IBS-related abdominal pain and stool consistency responders if they were both weekly IBS-related abdominal pain responders and weekly stool consistency responders in a given week for at least 2 weeks during Weeks 3 to 6 in the double-blind first repeat treatment phase. Weekly responder in IBS-related abdominal pain was defined as a 30% or greater improvement from baseline in the weekly average abdominal pain score. Weekly responder in stool consistency was defined as a 50% or greater reduction in the number of days in a week with stool consistency of type 6 or 7 compared with baseline. The p-value for this composite endpoint was < 0.05.

^d The p-value for responders was < 0.05.

Thirty-six of 308 (11.7%) of placebo patients and 56 of 328 (17.1%) of ZAXINE-treated patients responded to the first repeat treatment and did not have recurrence of signs and symptoms through the treatment-free follow-up period (10 weeks after first repeat treatment, p-value < 0.05). The response rate difference was 5.4% with 95% confidence interval (1.2% to 11.6%).

The overall safety profile during and following treatment and repeat treatment with rifaximin 550 mg TID in subjects with IBS-D was consistent with the population under study, was comparable to that observed with placebo in the double-blind repeat treatment phase, and was comparable to that observed after one 14-day rifaximin treatment course in the open-label phase and with previous Phase 3 studies (TARGET 1 and 2).

Results of the culture and susceptibility testing demonstrate no evidence of development of clinically significant bacterial resistance. There was also no rifaximin-mediated cross-resistance to non-rifamycin antibiotics in response to rifaximin treatment in isolates grown from either stool or skin swab cultures. Importantly, repeat treatment courses of rifaximin do not appear to predispose patients to the emergence of potentially pathogenic bacteria (e.g., *C. difficile*, *Enterococcus*, or *Staphylococcus*) in the stool or on the skin. A very small number of *C. difficile* isolates were identified in stool samples at a rate consistent with literature reports of asymptomatic carriers in the general population, and none of these isolates demonstrated rifaximin resistance.

DETAILED PHARMACOLOGY

ZAXINE (rifaximin) contains rifaximin- α , one of the polymorphic forms of rifaximin.

Mechanism of Action

See **ACTION AND CLINICAL PHARMACOLOGY**.

ANIMAL PHARMACOLOGY

Pharmacodynamics

The safety pharmacology, neurobehavioral, gastrointestinal, renal, cardiovascular, and neurological effects, were evaluated in mice, rats, cats, and dogs following single oral or intraduodenal doses ranging from 100 to 1000 mg/kg. In mice, rifaximin did not show significant pharmacologic effects on neurobehavior, locomotion, motor coordination, gastrointestinal motility, proconvulsant activity, hexobarbital-induced sleep time, and diazepam-inhibited seizure activity. No significant effects were seen on gastric acid secretion, gastric mucosa, or urinary volume and electrolyte excretion in rats. Rifaximin did not demonstrate significant effects on hemodynamics and respiration in dogs, rats or guinea pigs, or autonomic function in cats. Thus, from the safety pharmacology studies, the no effect level was 1000 mg/kg, equivalent to about 42.4 times greater than the daily therapeutic dose anticipated to be used in IBS-D. When factoring individual animal models this dose level is also about 4-fold (in mouse) to 23-fold (in dog) greater than the human IBS-D therapeutic dose, given that the daily maximum clinical dose is anticipated to be 1650 mg/d which is equivalent to 23.6 mg/kg or 944 mg/m² for a 70 kg subject with 1.7 m² total body surface area.

Pharmacokinetics

Following oral administration of ¹⁴C-rifaximin, the drug is poorly absorbed. Most of the radioactivity was demonstrated in the gastrointestinal tract. Systemic availability of orally administered ¹⁴C-rifaximin (24 mg/kg) was not more than 2-5% of the oral dose in rats or 0.5% of the oral dose in dogs. In rats, the majority of drug activity >96% was demonstrated in faeces, 0.6% in the liver and 0.01% in the kidney. Biliary excretion approximates 0.5% to 1.7% of the oral dose, suggesting that there is a significant first pass removal of rifaximin by the liver, for the small proportion of the oral dose absorbed. In dogs administered with 2.4 mg/kg IV ¹⁴C-rifaximin, the majority of the dose was recovered from faeces (83-93 %) while 0.45% from urine suggesting the faecal radioactivity from IV dose is probably initially excreted in bile. Effect of rifaximin on hepatic and intestinal drug metabolizing enzymes was evaluated *ex vivo* in CD rats. Following 50-300 mg/kg/day administration of rifaximin orally for 26 weeks in rats, rifaximin did not demonstrate significant induction potential in liver/GI tract.

In Vitro Study

In vitro interspecies comparison of metabolism of rifaximin in rat, rabbit, dog and human hepatocytes demonstrated that the rate of metabolism varied and was greatest for rabbit, followed by dog, rat and human. Large interspecies differences were reported in major metabolites formed. Different major metabolites were observed for each species. The major human

metabolite (25-desacetyl rifaximin) was not detected in rat and was demonstrated as a minor metabolite in rabbits and dogs.

HUMAN PHARMACOLOGY

In Vitro Studies

QT/QTc Prolongation

In vitro rifaximin concentrations of $\geq 30 \mu\text{M}$ (23,577 ng/mL) demonstrated a statistically significant increase in inhibition of the hERG channel; the IC_{50} was estimated to be $> 100 \mu\text{M}$ (78590 ng/mL).

Pharmacokinetics

Rifaximin is metabolized by CYP3A4. Multiple rifaximin metabolism pathways were identified, including deacetylation, demethylation, mono-oxidation, and desaturation. The major metabolite observed was 25-desacetyl rifaximin. Rifaximin has low potential to induce CYP3A4 enzyme activity [at a concentration of $0.2 \mu\text{M}$ (157 ng/ml)]. Rifaximin did not inhibit cytochrome P450 isozymes 1A2, 2A6, 2B6, 2C9, 2C19, 2D6, 2E1 and CYP3A4 at concentrations up to 200 ng/ml. However, at higher concentrations rifaximin inhibited CYP 3 A4 [$\text{IC}_{50} = 25 \mu\text{M}$, (19,648 ng/ml) equivalent to 900x the clinical unbound C_{max} in hepatically impaired patients]. Rifaximin is a substrate and a weak inhibitor of P-glycoprotein (P-gp). Rifaximin partly inhibited digoxin transport at $50 \mu\text{M}$ (39,316 ng/ml) through Caco-2 monolayers.

MICROBIOLOGY

Spectrum of Activity

Rifaximin has a broad antimicrobial spectrum.

Development of Resistance

Rifaximin is a structural analog of rifampin. Organisms with high rifaximin minimum inhibitory concentration (MIC) values also have elevated MIC values against rifampin. Cross-resistance between rifaximin and other classes of antimicrobials has not been studied.

Escherichia coli has been shown to develop resistance to rifaximin *in vitro*. However, the clinical significance of such an effect has not been studied.

TOXICOLOGY

Following single-dose toxicity, repeat-dose toxicity, genotoxicity, carcinogenicity and reproductive toxicity studies were conducted to investigate the toxicity of rifaximin.

Single-dose

Single oral doses of up to 2000 mg/kg rifaximin were nontoxic to mice and rats.

Repeat Dose

Oral administration of rifaximin for 3-6 months produced hepatic proliferation of connective tissue in rats (50 mg/kg/day) and fatty degeneration of liver in dogs (100 mg/kg/day). However, plasma drug levels were not measured in these studies. Rifaximin was studied at doses as high as 300 mg/kg/day in rats for 6 months and 1000 mg/kg/day in dogs for 9 months, and no signs of hepatotoxicity were observed. The maximum plasma AUC_{0-8 hr} values from the 6-month rat and 9-month dog toxicity studies (range: 42-127 ng•h/mL) was lower than the maximum plasma AUC_{0-8hr} values in cirrhotic patients (range: 19-306 ng•h/mL).

Repeat oral administration of rifaximin at 1000 mg/kg/d for 39 weeks was nontoxic to the dog. To achieve higher exposures to rifaximin, dogs were given 1000 mg/kg/d of the amorphous form of rifaximin by the oral route. The rate and extent of systemic exposure to rifaximin amorphous form was approximately 90-fold higher than for those administered rifaximin alpha. At week 26, except for orange-colored feces/fur and non-specific stress-induced thymic atrophy/involution, no consistent clinical pathologic or histopathologic changes attributable to rifaximin amorphous were observed in these dogs.

Genotoxicity

Rifaximin did not show evidence of mutagenic activity in a standard battery that included bacterial and yeast gene mutation assays, mammalian CHO/HGPRT gene mutation assay, chromosomal aberration assay with human lymphocytes, and *in vivo* tests e.g., rat bone marrow micronucleus assay. Rifaximin does not induce unscheduled DNA synthesis in primary rat hepatocytes and unscheduled DNA synthesis in rat hepatocytes after *in vivo* treatment.

Carcinogenicity

Malignant schwannomas in the heart were significantly increased in male Crl: CD rats that received rifaximin by oral gavage for two years at 150 to 250 mg/kg/day (doses equivalent to 1.3 to 2.2 times the recommended dose, based on relative body surface area comparisons). There was no increase in tumors in Tg.rasH2 mice dosed orally with rifaximin for 26 weeks at 150 to 2000 mg/kg/day (doses equivalent to 0.7 to 9 times the recommended daily dose based on relative body surface area comparisons).

Reproductive Toxicity and Fertility

In a rat embryofetal development study, a slight and transient delay in ossification that did not affect the normal development of the offspring, was observed at 300 mg/kg/day (equivalent to 2.6 times the clinical dose for hepatic encephalopathy, and approximately 1.8 times the recommended dose for IBS-D (1650 mg per day), adjusted for body surface area). In the rabbit, following oral administration of rifaximin during gestation, an increase in the incidence of skeletal variations was observed (at doses similar to clinical dose). The clinical relevance of these findings is not known. In another study in pregnant rabbits from Gestation Day 6 - 19 following administration of rifaximin 62.5- 1000 mg/kg/d orally for 14 days, rifaximin tissue concentrations were evaluated in the fetal and adult brain and liver, and in the placenta. In pregnant rabbits treated with rifaximin 250 and 1000 mg/kg/d, minimal rifaximin exposure to fetus was demonstrated.

REFERENCES

- Amenta M, Dalle Nogare ER, Colomba C, Prestileo TS, Di Lorenzo F, Fundaro S, Colomba A, Ferrieri A. Intestinal protozoa in HIV-infected patients: Effect of rifaximin in *Cryptosporidium parvum* and *Blastocystis hominis* infections. *J Chemother.* 1999 Oct; 11(5):391-395.
- Arguedas MR, DeLawrence TG and McGuire BM. Influence of hepatic encephalopathy on health-related quality of life in patients with cirrhosis. *Dig Dis Sci* 2003;48:1622.
- Bajaj JS, Schubert CM, Heuman DM, Wade JB, Gibson DP, Topaz A, Saeian K, Hafeezullah M, Bell DE, Sterling RK, Stravitz RT, Luketic V, White MB, Sanyal AJ. Gastroenterology. Persistence of cognitive impairment after resolution of overt hepatic encephalopathy. 2010 Jun;138(7):2332-2340.
- Bajaj JS, Riggio O, Allampati S, Prakash R, Gioia S, Onori E, Piazza N, Noble NA, White MB, Mullen KD. Cognitive dysfunction is associated with poor socioeconomic status in patients with cirrhosis: an international multicenter study. *Clin Gastroenterol Hepatol.* 2013 Nov;11(11):1511-1516.
- Bajaj JS, Wade JB, Gibson DP, Heuman DM, Thacker LR, Sterling RK, Stravitz RT, Luketic V, Fuchs M, White MB, Bell DE, Gilles H, Morton K, Noble N, Puri P, Sanyal AJ. The multi-dimensional burden of cirrhosis and hepatic encephalopathy on patients and caregivers. *Am J Gastroenterol.* 2011 Sep;106(9):1646-1653.
- Barbara G, DeGiorgio R, Stanghellini V, et al. A role for inflammation in irritable bowel syndrome. *Gut* 2002;51(Suppl.1):141-144.
- Bass NM, Mullen KD, Sanyal A et al. Rifaximin Treatment in Hepatic Encephalopathy. *N Eng J Med.* 2010;362:1071-81.
- Bustamante J, Rimola A, Ventura PJ, Navasa M, Cirera I, Reggiardo V, Rodés J. Prognostic significance of hepatic encephalopathy in patients with cirrhosis. *J Hepatol.* 1999 May;30(5):890-895.
- Collins SM. A role for the gut microbiota in IBS. *Nat Rev Gastroenterol Hepatol.* 2014 Aug;11(8):497-505.
- de Melo RT, Charneski L, Hilas O. Rifaximin for the treatment of hepatic encephalopathy. *Am J Health Syst Pharm.* 2008;65(9):818-22.
- Descombe JJ, Dubourg D, Picard M, Palazzini E. Pharmacokinetic Study of Rifaximin after Oral Administration in Healthy Volunteers. *Int J Clin Pharm Res.* 1994;2:51-56.

- D'Amico G, Morabito A, Pagliaro L, Marubini E. Survival and prognostic indicators in compensated and decompensated cirrhosis. *Dig Dis Sci*. 1986 May;31(5):468-475.
- Drossman DA, Li Z, Andruzzi RD, et al. U.S. householder survey of functional gastrointestinal disorders. Prevalence, sociodemography, and health impact. *Dig Dis Sci* 1993;38:1569-1580.
- Farndale R, Roberts L. Long-term impact of irritable bowel syndrome: a qualitative study. *Prim Health Care Res Dev*. 2011;12(1):52-67.
- Fedorak RN, Vanner SJ, Paterson WG, et al. Canadian Digestive Health Foundation Public Impact Series 3: Irritable bowel syndrome in Canada. Incidence, prevalence, and direct and indirect economic impact. *Can J Gastroenterol*. 2012 May;26(5):252-256.
- Fera G, Francesco A, Michele N, Oronzo S, Antonella F. Rifaximin for the treatment of hepatic encephalopathy. *Eur J Clinical Res*. 1993;4:57-66.
- Festi D, Mazzella G, Orsini M, et al. Rifaximin in the treatment of chronic hepatic encephalopathy: Results of a multicenter study of efficacy and safety. *Curr Ther Res*. 1993;54:598-609.
- Gao J1, Gilliland MG 3rd1, Owyang C1. Rifaximin, gut microbes and mucosal inflammation: unraveling a complex relationship. *Gut Microbes* 2014 Jul 1;5(4):571-575.
- Hoffman JT, Hartig C, Sonbol E, Lang M. Probable interaction between warfarin and rifaximin in a patient treated for small intestine bacterial overgrowth. *Annals Pharmacother*. 2011;45: e25.
- Keohane J, O'Mahony C, O'Mahony L, et al. Irritable bowel syndrome-type symptoms in patients with inflammatory bowel disease: A real association or reflection of occult inflammation? *Am J Gastroenterol* 2010;105:1788-1794.
- Lawrence KR, Klee JA. Rifaximin for the treatment of hepatic encephalopathy. *Pharmacotherapy*. 2008;28(8):1019-32.
- Loguercio C, Federico A, De Girolamo V, Ferrieri A, Del Vecchio Blanco C. Cyclic treatment of chronic hepatic encephalopathy with rifaximin. Results of a double-blind clinical study. *Minerva Gastroenterol Dietol*. 2003;49:53-62.
- Longstreth GF, Thompson WG, Chey WD et al. Functional bowel disorders. *Gastroenterology* 2006;130:1480-1491.
- Ma X, Shah YM, Guo GL, Wang T, Krausz KW, Idle JR, Gonzalez FJ. Rifaximin is a gut-specific human pregnane X receptor activator. *J Pharmacol Exp Ther*. 2007 Jul;322(1):391-8.
- McCrea M, Cordoba J, Vessey G, Blei AT, Randolph C. Neuropsychological characterization and detection of subclinical hepatic encephalopathy. *Arch Neurol*. 1996;53:758-763.

Mencarelli A, Renga B, Palladino G, Claudio D, Ricci P, Distrutti E, Barbanti M, Baldelli F, Fiorucci S. Inhibition of NF- κ B by a PXR-dependent pathway mediates counter-regulatory activities of rifaximin on innate immunity in intestinal epithelial cells. *Eur J Pharmacol.* 2011 Oct 1; 668(1-2):317-324.

Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria that Grow Aerobically; Approved Standard Ninth Edition. CLSI document M07-A9. Wayne, PA: Clinical and Laboratory Standards Institute, 2012.

Methods for Antimicrobial Susceptibility Testing of Anaerobic Bacteria; Approved Standard Eighth Edition. CLSI document M11-A8. Wayne, PA: Clinical and Laboratory Standards Institute, 2012.

Miglio F, Valpiani D, Rossellini SR, Ferrieri A. Rifaximin, a non-absorbable rifamycin, for treatment of hepatic encephalopathy. A double-blind, randomized trial. *Curr Med Res Opin.* 1997;13:593-601.

Mullen KD, Sanyal AJ, Bass NM, Poordad FF, Sheikh MY, Frederick RT, Bortey E, Forbes WP. Rifaximin is safe and well tolerated for long-term maintenance of remission from overt hepatic encephalopathy. *Clin Gastroenterol Hepatol.* 2014 Aug;12(8):1390-1397.e2.

Muscattello MR, Bruno A, Pandolfo G, Mico U, Stilo S, Scaffidi M, et al. Depression, anxiety and anger in subtypes of irritable bowel syndrome patients. *J Clin Psychol Med Settings.* 2010;17(1):64-70.

Ong JP, Aggarwal A, Krieger D, Easley KA, Karafa MT, and Van Lente F, et al. Correlation between ammonia levels and the severity of hepatic encephalopathy. *Am J Med.* 2003;114:188-93.

Pace F, Molteni P, Bollani S, Sarzi-Puttini P, Stockbrugger R, Bianchi Porro G, et al. Inflammatory bowel disease versus irritable bowel syndrome: a hospital-based, case-control study of disease impact on quality of life. *Scand J Gastroenterol.* 2003;38(10):1031-1038.

Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Fourth Informational Supplement. CLSI document M100-S2. Wayne, PA: Clinical and Laboratory Standards Institute, 2014.

Pimentel M, Chow EJ, Lin HC. Eradication of small intestinal bacterial overgrowth reduces symptoms of irritable bowel syndrome. *Am J Gastroenterol* 2000;95:3503-3506.

Posserud I, Stotzer PO, Bjornsson ES, et al. Small intestinal bacterial overgrowth in patients with irritable bowel syndrome. *Gut* 2007;56:802-808.

Pylaris E, Giamarellos-Bourboulis EJ, Tzivras D, et al. The prevalence of overgrowth by aerobic bacteria in the small intestine by small bowel culture: relationship with irritable bowel syndrome. *Dig Dis Sci* 2012;57:1321-1329.

Quigley EM1, Fried M, Gwee KA, Khalif I, Hungin AP, Lindberg G, Abbas Z, Fernandez LB, Bhatia SJ, Schmulson M, Olano C, LeMair A; World Gastroenterology Organisation Global Guidelines Irritable Bowel Syndrome: A Global Perspective Update September 2015. *J Clin Gastroenterol*. 2016 Oct;50(9):704-713.

Romero-Gómez M1, Boza F, García-Valdecasas MS, García E, Aguilar-Reina J. Subclinical hepatic encephalopathy predicts the development of overt hepatic encephalopathy. *Am J Gastroenterol*. 2001 Sep;96(9):2718-2723.

Sanyal A, Younossi ZM, Bass NM, et al. Randomised clinical trial: rifaximin improves health-related quality of life in cirrhotic patients with hepatic encephalopathy - a double-blind placebo-controlled study. *Aliment Pharmacol Ther*. 2011;34(8):853-61.

Scarpignato C, Pelosini I. Rifaximin, a poorly absorbed antibiotic: pharmacology and clinical potential. *Chemotherapy*. 2005; 51 Suppl 1():36-66.

Talley NJ, Zinsmeister AR, Van Dyke C, Melton LJ 3rd. Epidemiology of colonic symptoms and the irritable bowel syndrome. *Gastroenterology*. 1991 Oct;101(4):927-934.

Thompson WG, Irvine EJ, Pare P, et al. Functional gastrointestinal disorders in Canada: first population-based survey using Rome II criteria with suggestions for improving the questionnaire. *Dig Dis Sci*. 2002 Jan;47(1):225-235.

Umezawa H, Mizuno S, Yamazaki H, Nitta K. Inhibition of DNA-dependent RNA synthesis by rifamycins. *J Antibiot (Tokyo)*. 1968 Mar; 21(3):234-236.

Verardi S, Verardi V. Bile rifaximin concentration after oral administration in patients undergoing cholecystectomy. *Farmaco*. 1990;45(1):131-135.

Vilstrup H, Amodio P, Bajaj J, Cordoba J, Ferenci P, Mullen KD, Weissenborn K, Wong P. Hepatic encephalopathy in chronic liver disease: 2014 practice guideline by the European Association for the Study of the Liver and the American Association for the Study of Liver Diseases. *J Hepatol*. 2014 Sep;61(3):642-659.

Whitehead WE, Burnett CK, Cook E3, Taub E. Impact of irritable bowel syndrome on quality of life. *Dig Dis Sci*.1996;41(11):2248-2253.

Williams R, Bass N. Rifaximin, a nonabsorbed oral antibiotic, in the treatment of hepatic encephalopathy: Antimicrobial activity, efficacy, and safety. *Rev Gastroenterol Disord* 2005;5(suppl 1):S10-S18.

Xu D1, Gao J1, Gilliland M 3rd1, Wu X1, Song I1, Kao JY1, Owyang C2. Rifaximin alters intestinal bacteria and prevents stress-induced gut inflammation and visceral hyperalgesia in rats. *Gastroenterology* 2014 Feb;146(2):484-496.e4.

Zeneroli ML, Avallone R, Corsi L, Venturini I, Baraldi C, Baraldi M. Management of hepatic encephalopathy: role of rifaximin. *Chemotherapy*. 2005;51 Suppl 1:90-5.

PART III: CONSUMER INFORMATION**PrZAXINE
rifaximin tablets**

This leaflet is part III of a three-part "Product Monograph" published when ZAXINE was approved for sale in Canada and is designed specifically for Consumers. This leaflet is a summary and will not tell you everything about ZAXINE. Contact your doctor or pharmacist if you have any questions about the drug.

ABOUT THIS MEDICATION**What the medication is used for:**

ZAXINE is an antibiotic that acts on the bacteria in the gut.

Hepatic Encephalopathy

ZAXINE is used to help prevent recurring episodes of a condition called **hepatic encephalopathy (HE)**. It may be used in conjunction with lactulose, as directed by your doctor. HE occurs when the liver is not working properly and cannot remove toxins from the blood which affect brain function.

ZAXINE is intended to be used for preventing HE only in those adult patients where HE is likely to occur again.

Antibacterial drugs like ZAXINE treat only bacterial infections. They do not treat viral infections.

Irritable Bowel Syndrome with Diarrhea

ZAXINE is used to treat **irritable bowel syndrome with diarrhea (IBS-D)** in adults.

What it does:**Hepatic Encephalopathy**

ZAXINE is thought to work by reducing the production of toxins released into the blood by bacteria in the gut.

Irritable Bowel Syndrome with Diarrhea

ZAXINE is thought to work by reducing the amount of bacteria and bacterial products in the gut. This can help with the most common symptoms of IBS-D which include bloating, abdominal pain and diarrhea.

When it should not be used:

If you are allergic (hypersensitive) to the active substance rifaximin, rifamycin antibacterial agents, or any of the other ingredients of ZAXINE (see **What the nonmedicinal ingredients are**).

What the medicinal ingredient is:

The active substance is rifaximin.

What the nonmedicinal ingredients are:

colloidal silicon dioxide, glyceryl distearate, microcrystalline cellulose, polyethylene glycol, polyvinyl alcohol, red iron oxide, gluten-free sodium starch glycolate, talc, and titanium dioxide.

What dosage forms it comes in:

Tablets: 550 mg

WARNINGS AND PRECAUTIONS

BEFORE you use ZAXINE talk to your doctor or pharmacist if:

- You have severe liver problems – there is an increase in systemic (blood) exposure to rifaximin in subjects with severe liver disease.
- You have any allergies to this drug or its ingredients.
- You are pregnant or think you may be pregnant, ask your doctor or pharmacist for advice before taking this medicine. Your doctor can discuss with you the risks and benefits involved.
- You are breastfeeding ask your doctor or pharmacist for advice before taking this medicine. It is not known whether rifaximin passes into breast milk.
- ZAXINE should not be used in children or adolescents less than 18 years of age, as there is no information on the use in that population.

INTERACTIONS WITH THIS MEDICATION

Tell your doctor or pharmacist if you are using, have recently used, or might use any other medicines, including non-prescription or herbal medicines. Tell your doctor if you are taking warfarin or oral contraceptives.

PROPER USE OF THIS MEDICATION

ZAXINE can be taken with or without food.

ZAXINE tablets should be swallowed whole with plenty of water. Do not crush tablets.

Although you may feel better early in treatment, ZAXINE should be used exactly as directed.

Do not misuse or overuse ZAXINE.

Do not share your medicine.

Usual adult dose:**Hepatic Encephalopathy**

The recommended dosage is one tablet twice daily.

Irritable Bowel Syndrome with Diarrhea

The recommended dosage is one tablet three times a day for 14 days. If your symptoms come back, your doctor may consider retreatment when needed.

Overdose:

In case of drug overdose, contact a health professional, hospital emergency department or regional Poison Control Centre immediately, even if there are no symptoms.

Missed Dose:

If you forget to take a dose, it should be taken as soon as possible. However, if it is almost time for the next dose, no additional dose should be taken and the regular dosing schedule should be resumed.

If you are taking ZAXINE for Hepatic Encephalopathy:
No more than two doses of ZAXINE (1 tablet twice a day) should be taken in a 24-hour period.

If you are taking ZAXINE for Irritable Bowel Syndrome with Diarrhea:

No more than three doses of ZAXINE (1 tablet three times a day) should be taken in a 24-hour period.

If you have trouble remembering to take your medicine, ask your pharmacist for some hints.

SIDE EFFECTS AND WHAT TO DO ABOUT THEM

Like all medicines, this medicine can cause side effects, although not everybody gets them. The most common side effects reported with ZAXINE are:

- Diarrhea
- Nausea
- Vomiting
- Abdominal pain or bloating
- Muscle spasms
- Dizziness or unsteadiness
- Headache
- Itchiness

ZAXINE may cause a reddish discolouration of the urine, tears and sweat.

ZAXINE can cause abnormal blood test results. Your doctor will decide when to perform blood tests and will interpret the results.

If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet.

SERIOUS SIDE EFFECTS, HOW OFTEN THEY HAPPEN AND WHAT TO DO ABOUT THEM

Symptom / effect		Talk with your doctor or pharmacist		Stop taking drug and get immediate medical help
		Only if severe	In all cases	
Unknown	Allergic Reaction: rash, hives, swelling of the face, lips, tongue or throat, difficulty swallowing or breathing			√
Rare	Clostridium difficile colitis (gut inflammation): severe diarrhea (bloody or watery) with or without fever, abdominal pain, or tenderness		√	

This is not a complete list of side effects. For any unexpected effects while taking ZAXINE, contact your doctor or pharmacist.

HOW TO STORE IT

Keep this medicine out of the sight and reach of children.

Do not use this medicine after the expiry date which is stated on the bottle, after “EXP:”. The expiry date refers to the last day of that month.

ZAXINE should be stored at room temperature (15°C to 30°C) in a tightly closed container away from heat and direct light.

Medicines should not be disposed of via wastewater or household waste. Ask your pharmacist how to throw away medicines you no longer use. These measures will help to protect the environment.

Reporting Side Effects

You can report any suspected side effects associated with the use of health products to Health Canada by:

- Visiting the Web page on Adverse Reaction Reporting (<https://www.canada.ca/en/health-canada/services/drugs-health-products/medeffect-canada/adverse-reaction-reporting.html>) for information on how to report online, by mail or by fax; or
- Calling toll-free at 1-866-234-2345.

NOTE: Contact your healthcare professional if you need information about how to manage your side effects. The Canada Vigilance Program does not provide medical advice.

MORE INFORMATION

This document plus the full product monograph, prepared for health professionals can be found at the Health Canada website www.canada.ca/en/health-canada.html; the manufacturer's website www.bauschhealth.com, the importer website www.lupinpharma.ca or by calling 1-844-587-4623.

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