

AUSTRALIAN PRODUCT INFORMATION – ENTECAVIR APO (ENTECAVIR MONOHYDRATE)

1 NAME OF THE MEDICINE

Entecavir monohydrate.

2 QUALITATIVE AND QUANTITATIVE COMPOSITION

Each tablet contains 0.5 mg or 1 mg entecavir (as monohydrate).

Excipients with known effects: lactose.

For the full list of excipients, see Section 6.1 List of Excipients.

3 PHARMACEUTICAL FORM

0.5 mg film-coated tablet is white to off-white, triangular shaped film coated tablets, debossed with 'RL1' on one side and plain on other side.

1.0 mg film-coated tablet is light pink to pink, triangular shaped film coated tablets, debossed with 'RL2' on one side and plain on other side.

4 CLINICAL PARTICULARS

4.1 THERAPEUTIC INDICATIONS

Entecavir is indicated for the treatment of chronic hepatitis B virus infection in adults 16 years or older with evidence of active liver inflammation.

This indication is based on histologic, virologic, biochemical and serological responses in nucleoside-treatment naïve and lamivudine-resistant adult patients with HBeAg-positive or HBeAg-negative chronic HBV infection with compensated liver disease.

4.2 DOSE AND METHOD OF ADMINISTRATION

Recommended dosage

Entecavir should be taken orally, on an empty stomach (at least 2 hours after a meal and at least 2 hours before the next meal).

The recommended oral dose of entecavir in adults and adolescents older than 16 years is 0.5 mg once daily. For lamivudine-refractory patients [history of hepatitis B viremia while receiving lamivudine therapy or known lamivudine resistance (LVD^R commonly called YMDD mutations)], the recommended dose is 1 mg once daily.

Renal impairment

In patients with renal impairment, the apparent oral clearance of entecavir decreased as creatinine clearance decreased (see Section 5.2 Pharmacokinetic Properties, Special populations). Dosage adjustment of entecavir is recommended for patients with creatinine clearance < 50 mL/min, including patients on hemodialysis or CAPD, as shown in **Table 1**.

Table 1. Recommended Dosage of Entecavir in Patients with Renal Impairment

Creatinine Clearance (mL/min)	Nucleoside Naïve	Lamivudine Refractory
≥ 50	0.5 mg once daily	1.0 mg once daily
30 to < 50	0.25 mg once daily* or 0.5 mg every 48 hours	0.5 mg once daily or 1.0 mg every 48 hours
10 to < 30	0.15 mg once daily* or 0.5 mg every 72 hours	0.3 mg once daily* or 1.0 mg every 72 hours
< 10	0.05 mg once daily* or 0.5 mg every 5–7 days	0.1 mg once daily* or 1.0 mg every 5–7 days
Haemodialysis or CAPD **	0.05 mg once daily* or 0.5 mg every 5–7 days	0.1 mg once daily* or 1.0 mg every 5–7 days

* For doses < 0.5 mg Entecavir Oral Solution¹ is recommended. Do not split tablets.

** On haemodialysis days, administer after haemodialysis.

Hepatic impairment

No dosage adjustment is necessary for patients with hepatic impairment.

Duration of therapy

The optimal duration of treatment with entecavir for patients with chronic hepatitis B infection and the relationship between treatment and long-term outcomes such as cirrhosis and hepatocellular carcinoma are unknown.

4.3 CONTRAINDICATIONS

This medicine is contraindicated in patients with previously demonstrated hypersensitivity to entecavir or any component of the product.

4.4 SPECIAL WARNINGS AND PRECAUTIONS FOR USE

Co-infection with human immunodeficiency virus (HIV)

Therapy with entecavir is not recommended for HIV/hepatitis B virus (HBV) co-infected patients who are not receiving highly active antiretroviral therapy. There is a potential for the development of HIV resistance if entecavir is used to treat chronic hepatitis B infection in patients with untreated HIV infection.

Lactic acidosis

Lactic acidosis and severe hepatomegaly with steatosis, including fatal cases, have been reported with the use of nucleoside analogues alone or in combination with antiretrovirals.

Exacerbations of hepatitis after discontinuation of treatment

Acute exacerbation of hepatitis has been reported in patients who have discontinued hepatitis B therapy, including therapy with entecavir monohydrate (see Section 4.8 Adverse Effects). The majority of post-treatment exacerbations appear to be self-limited. However,

¹ Entecavir oral solution is unavailable in this brand, however is available in other brands

severe exacerbations, including fatalities, may occur. Hepatic function should be monitored closely for at least several months after discontinuation. If appropriate, resumption of hepatitis B therapy may be warranted.

Use in renal impairment

Dosage adjustment of entecavir monohydrate is recommended for patients with renal impairment who have creatinine clearance < 50 mL/min (see Section 4.2 Dose and Method of Administration).

Liver transplant recipients

Limited data are available on the safety and efficacy of entecavir in liver transplant recipients. In a single-arm, open-label study, patients who had HBV DNA less than 172 IU/mL at the time of transplant were treated with entecavir 1 mg once daily post-transplant. On treatment, 15 subjects (23%) had liver-related adverse events of interest: fourteen subjects had ascites (22%) and 1 subject each had bacterial peritonitis, hepatic encephalopathy and recurrent hepatocellular carcinoma (HCC). In 12 of the 15 subjects, all liver-related events occurred during the first 30 days post-transplant and were considered post-operative complications. During the first 30 days post-transplant, 18 of 65 treated subjects (28%) or 8 of 61 evaluable subjects (13%) had episodes of acute liver rejection with 1 subject who required re-transplantation. None of the 61 evaluable patients had virologic recurrence. The frequency and nature of adverse events and acute liver rejection in this study were consistent with those expected in patients who have received a liver transplant and the known safety profile of entecavir monohydrate (see Section 5.1 Pharmacodynamic Properties, Clinical trials).

Renal function should be carefully monitored before and during entecavir therapy in liver transplant recipients receiving an immunosuppressant that may affect renal function such as cyclosporine or tacrolimus (see Section 4.2 Dose and Method of Administration, Hepatic impairment and Section 5.2 Pharmacokinetic Properties, Special populations, Hepatic impairment and Post-liver transplant).

Decompensated liver disease

A study of entecavir at a dose of 1 mg once daily has been conducted in patients with decompensated liver disease (see Section 4.8 Adverse Effects and Section 5.1 Pharmacodynamic Properties, Clinical trials).

Co-infection with hepatitis C or D

There are no data on the efficacy of entecavir in patients co-infected with hepatitis C or D.

Paediatric use

Safety and effectiveness of entecavir in paediatric patients below the age of 16 years have not been established.

Use in the elderly

Clinical studies of entecavir did not include sufficient numbers of participants aged 65 years and over to determine whether they respond differently from younger participants. Other reported clinical experience has not identified differences in responses between the elderly and younger patients. Entecavir is substantially excreted by the kidney and the risk of toxic reactions to this drug may be greater in patients with impaired renal function. Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection and it may be useful to monitor renal function (see Section 4.2 Dose and Method of Administration, Renal impairment).

Lactose

This medicine contains 112.5 mg of lactose in each 0.5 mg daily dose and 225 mg of lactose in each 1 mg daily dose. Patients with rare hereditary problems of galactose intolerance, the Lapp lactase deficiency or glucose-galactose malabsorption should not take this medicine.

Effects on laboratory tests

No data available.

Patient information

A Consumer Medicine Information leaflet for this medicine is available for patient information.

Patients should remain under the care of a physician while taking entecavir. They should discuss any new symptoms or concurrent medications with their physician.

Patients should be advised to take entecavir on an empty stomach (at least 2 hours before and at least 2 hours after a meal).

Patients should be informed that deterioration of liver disease may occur in some cases if treatment is discontinued and that they should discuss any change in regimen with their physician.

Patients should be advised that treatment with entecavir has not been shown to reduce the risk of transmission of HBV to others through sexual contact or blood contamination (see Section 4.6 Fertility, Pregnancy and Lactation, Use in pregnancy).

4.5 INTERACTIONS WITH OTHER MEDICINES AND OTHER FORMS OF INTERACTIONS

Medicinal products

Since entecavir is predominantly eliminated by the kidney (see Section 5.2 Pharmacokinetic Properties, Excretion), co-administration with medicinal products that reduce renal function or compete for active tubular secretion may increase serum concentrations of either medicinal product. Co-administration of entecavir with either lamivudine, adefovir dipivoxil or tenofovir disoproxil fumarate resulted in no significant drug interactions. The effects of co-administration of entecavir with other medicinal products that are excreted renally or affect renal function have not been evaluated. Patients should be monitored closely for adverse events when entecavir is co-administered with such medicinal products.

4.6 FERTILITY, PREGNANCY AND LACTATION

Effects on fertility

Male and female rat fertility was unaffected by drug exposures (AUC) up to approximately 160 (male) and 230 (female) times that in humans treated with a daily dose of 1 mg. Testicular seminiferous tubule degeneration or germinal epithelial maturation arrest was observed in long-term rodent studies, at drug exposures that were ≥ 10 (mice) and 29 (rats) times the human value and in dog studies at exposures > 379 times the human value. No testicular changes were evident in monkeys at exposures up to 114 times the clinical exposure.

Use in pregnancy

Category B3

There are no adequate and well-controlled studies in pregnant women. Entecavir should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

There are no data on the effect of entecavir on transmission of HBV from mother to infant. Therefore, appropriate interventions should be used to prevent neonatal acquisition of HBV.

In animal experiments, embryofetal development was unaffected at drug exposures (AUC) of up to 23 (rats) and 175 (rabbits) times the maximum human exposure (1 mg daily dose). Slightly increased resorptions occurred in rats at a maternotoxic dose resulting in a higher drug exposure (150 times the human value), while embryofetal development was severely retarded at a maternotoxic dose resulting in a drug exposure > 2500 times the human value; tail and vertebral malformations were observed. A drug exposure 730 times the maximum human value resulted in increased resorptions and incomplete fetal hyoid ossification in rabbits, in the absence of maternal toxicity. Rat offspring development was unaffected at drug exposures approximately 230 times the human value, when mothers were treated from early gestation to the end of lactation.

Pregnancy Registry

To monitor maternal-fetal outcomes of pregnant women exposed to entecavir, a Pregnancy Registry has been established. Physicians are encouraged to register patients by calling 1800 067 567.

Use in lactation

Entecavir and/or its conjugate metabolites are excreted in the milk of rats. It is not known whether excretion occurs in human milk. Mothers should be instructed not to breast-feed if they are taking entecavir monohydrate.

4.7 EFFECTS ON ABILITY TO DRIVE AND USE MACHINES

The effects of this medicine on a person's ability to drive and use machines were not assessed as part of its registration.

4.8 ADVERSE EFFECTS (UNDESIRABLE EFFECTS)

Assessment of adverse reactions is based on four clinical studies in which 1,720 patients with chronic HBV infection received double-blind treatment with entecavir monohydrate 0.5 mg/day (n = 679), entecavir monohydrate 1 mg/day (n = 183) or lamivudine (n = 858) for up to 107 weeks. The safety profiles of entecavir and lamivudine were comparable in these studies. Among entecavir-treated patients, the most common adverse events of any severity with at least a possible relation to entecavir were headache (9%), fatigue (6%), dizziness (4%) and nausea (3%).

In these clinical studies, the 594 entecavir-treated patients who received blinded therapy for more than 52 weeks reported adverse reactions similar in nature and severity to those reported during the first 52 weeks of treatment.

Clinical trials adverse events

Selected clinical adverse events of moderate-severe intensity and considered at least possibly related to treatment occurring during therapy in four clinical studies in which entecavir monohydrate was compared to lamivudine are presented in **Table 2**.

Table 2. Selected Clinical Adverse Events^a of Moderate-Severe Intensity (Grades 2–4) Reported in Four Entecavir Clinical Trials

Body System/ Adverse Event	Nucleoside-Naïve ^b		Lamivudine-Refractory ^c	
	Entecavir 0.5 mg (n = 679)	Lamivudine 100mg (n = 668)	Entecavir 1 mg (n = 183)	Lamivudine 100 mg (n = 190)
Gastrointestinal				
Diarrhea	< 1%	0	1%	0
Dyspepsia	< 1%	< 1%	1%	0
Nausea	< 1%	< 1%	< 1%	2%
Vomiting	< 1%	< 1%	< 1%	0
General				
Fatigue	1%	1%	3%	3%
Nervous System				
Headache	2%	2%	4%	1%
Dizziness	< 1%	< 1%	0	1%
Somnolence	< 1%	< 1%	0	0
Psychiatric				
Insomnia	< 1%	< 1%	0	< 1%

a Includes events of possible, probable, certain or unknown relationship to treatment regimen.

b Studies AI463022 and AI463027.

c Includes Study AI463206 and the entecavir monohydrate 1-mg and lamivudine treatment arms of Study AI463014 a Phase 2 multinational, randomized, double-blind study of three doses of entecavir monohydrate (0.1, 0.5 and 1 mg) once daily versus continued lamivudine 100 mg once daily for up to 52 weeks in patients who experienced recurrent viremia on lamivudine therapy.

Laboratory findings

Table 3 shows laboratory findings from four double-blind, lamivudine-controlled clinical studies in which 679 nucleoside-naïve patients received entecavir 0.5 mg once daily for a median of 53 weeks and 183 lamivudine-refractory patients received entecavir 1 mg for a median of 69 weeks.

Table 3. Selected Laboratory Abnormalities Reported During Treatment in Four Clinical Trials

Test	Nucleoside-Naïve ^a	Lamivudine-Refractory ^b
	Entecavir 0.5 mg (n = 679)	Entecavir 1 mg (n = 183)
ALT > 10x ULN and > 2x baseline	2%	2%
ALT > 3x baseline	5%	4%
ALT > 2x baseline and total bilirubin > 2x ULN and > 2x baseline	< 1%	< 1%
Albumin < 2.5 g/dL	< 1%	0

Test	Nucleoside-Naïve ^a	Lamivudine-Refractory ^b
	Entecavir 0.5 mg (n = 679)	Entecavir 1 mg (n = 183)
Amylase > 3x baseline	2%	2%
Lipase > 3x baseline	12%	18%
Platelets < 50,000/mm ³	< 1%	< 1%

a Median duration of therapy was 53 weeks.

b Median duration of therapy was 69 weeks.

ULN = upper limit of normal.

Among entecavir-treated patients in these studies, on-treatment ALT elevations > 10x ULN and > 2x baseline generally resolved with continued treatment. A majority of these exacerbations were associated with a >2 log₁₀/mL reduction in viral load that preceded or coincided with the ALT elevation. Periodic monitoring of hepatic function is recommended during treatment.

ALT flares after discontinuation of treatment

Acute exacerbations of hepatitis have been reported in patients who have discontinued anti-HBV therapy, including therapy with entecavir monohydrate (see Section 4.4 Special Warnings and Precautions for Use). The frequency of exacerbations of hepatitis or ALT flare (defined as ALT > 10x ULN and 2x the patient's reference level) during off-treatment follow-up in clinical studies with entecavir is presented in **Table 4**.

Table 4. ALT Flares During Off-Treatment Follow-up in Studies AI463022, AI463026 and AI463027

	Patients with ALT Elevations > 10x ULN and > 2x Reference ^a	
	Entecavir	Lamivudine
Nucleoside-naïve	28/476 (6%)	43/417 (10%)
HBeAg-positive	4/174 (2%)	13/147 (9%)
HBeAg-negative	24/302 (8%)	30/270 (11%)
Lamivudine-refractory	6/52 (12%)	0/16

a Reference is the minimum of the baseline or last measurement at end of dosing. Median time to off-treatment exacerbation was 23 weeks for entecavir-treated patients and 10 weeks for lamivudine-treated patients.

Patients with decompensated liver disease

Clinical adverse reactions observed through Week 48 in Study AI463048 in which entecavir monohydrate 1mg once daily was compared with adefovir dipivoxil in patients with chronic hepatitis B infection and decompensated liver disease are listed in **Table 5**. The cumulative rates of discontinuation for adverse events and on-study cumulative rates of death and HCC are also shown in **Table 5**.

**Table 5. Selected Safety Outcomes in Study AI463048:
Clinical Adverse Events^a of Moderate-Severe Intensity (Grades 2–4) Through Week 48**

Body System/ Adverse Event	Entecavir 1 mg (n = 102)	Adefovir dipivoxil 10 mg (n = 89)
Gastrointestinal Disorders		
Vomiting	< 1%	1%
Diarrhea	0	1%
Investigations		
Blood bicarbonate decreased	2%	0
Nervous System Disorders		
Dizziness	2%	0
Headache	0	1%
Renal and Urinary Disorders		
Renal failure	< 1%	2%
General Disorders and Administration Site Conditions		
Fatigue	< 1%	1%
Discontinuation for Adverse Event (cumulative)	7%	6%
Deaths (cumulative)	23%	33%
HCC (cumulative)	12%	20%

a Includes events of possible, probable, certain or unknown relationship to treatment regimen.

Causes of death in Study AI463048 were generally liver-related, as expected in this population. The time to onset of HCC or death (whichever occurred first) was comparable in the two treatment groups.

Laboratory test abnormalities reported through Week 48 in study AI463048 are listed in **Table 6**.

**Table 6. Selected Laboratory Abnormalities Reported Through Week 48
in Study AI463048**

Test	Entecavir 1 mg (n = 102)
ALT > 10x ULN and > 2x baseline	0
ALT > 2x baseline and total bilirubin > 2x ULN and > 2x baseline	1%
Albumin < 2.5 g/dL	30%
Lipase > 3x baseline	10%
Platelets < 50,000/mm ³	20%

ULN = upper limit of normal.

Patients co-infected with HIV

Patients co-infected with HBV and HIV who experienced recurrence of HBV viremia while receiving a lamivudine-containing highly active antiretroviral regimen were treated with their lamivudine-containing regimen (lamivudine dose, 300 mg/day) and either entecavir 1 mg once daily or placebo. After 24 weeks of double-blind therapy and a mean of 17 weeks of open-label therapy (where all patients received entecavir), the adverse event and laboratory abnormality profiles were similar for the entecavir and placebo treatment groups. Entecavir has not been evaluated in HIV/HBV co-infected patients who are not concurrently receiving effective HIV treatment (see Section 4.4 Special Warnings and Precautions for Use, Co-infection with HIV).

Post-marketing experience

The following events have been identified during post-approval use of entecavir. Because reports are voluntary from a population of unknown size, an estimate of frequency cannot be made.

<i>Immune system disorders:</i>	anaphylactoid reaction.
<i>Skin and subcutaneous tissue disorders:</i>	alopecia, rash.
<i>Hepatobiliary disorders:</i>	increased transaminases.
<i>Metabolism and nutrition disorders:</i>	Lactic acidosis, often in association with hepatic decompensation, other serious medical conditions or drug exposures.

Reporting suspected adverse effects

Reporting suspected adverse reactions after registration of the medicinal product is important. It allows continued monitoring of the benefit-risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions at <http://www.tga.gov.au/reporting-problems>

4.9 OVERDOSE

There is limited experience of entecavir overdosage reported in patients. Healthy participants who received single entecavir doses up to 40 mg or multiple doses up to 20 mg/day for up to 14 days had no increase in or unexpected adverse events. If overdose occurs, the patient must be monitored for evidence of toxicity and standard supportive treatment applied as necessary.

Following a single 1 mg dose of entecavir, a 4-hour hemodialysis session removed approximately 13% of the entecavir dose.

For information on the management of overdose, contact the Poisons Information Centre on 13 11 26 (Australia).

5 PHARMACOLOGICAL PROPERTIES

5.1 PHARMACODYNAMIC PROPERTIES

Mechanism of action

Entecavir is a guanosine nucleoside analogue with activity against HBV polymerase. It is phosphorylated to the active triphosphate (TP) form, which has an intracellular half-life of 15 hours. Intracellular TP levels are directly related to extracellular entecavir concentrations, with no significant accumulation beyond initial plateau levels. By competing with the natural substrate deoxyguanosine-TP, entecavir-TP inhibits all 3 functional activities of the viral

polymerase: (1) priming of the HBV polymerase (2) reverse transcription of the negative strand from the pre-genomic messenger RNA and (3) synthesis of the positive strand of HBV DNA. Entecavir-TP K_i value for inhibition of HBV DNA polymerase is 1.2 nM. Entecavir-TP is a weak inhibitor of cellular DNA polymerases α , β , δ and ϵ with K_i values of 18 to 40 μ M. It did not inhibit mitochondrial γ polymerase ($K_i > 160 \mu$ M) and did not affect the mitochondrial DNA content of human hepatoma cells *in vitro*. Entecavir inhibited HBV DNA synthesis at a concentration of 0.004 μ M in human HepG2 cells transfected with wild-type HBV. IC_{50} values for entecavir against lamivudine-resistant HBV ranged 0.029–0.061 μ M.

Resistance *in vitro*

There was reduced susceptibility to entecavir when LVD^R substitutions (M204I/V \pm L180M) were present. Entecavir inhibited the replication of LVD^R HBV at 8-fold higher concentrations than that for the wild-type virus in cell-based studies. At extracellular concentrations representative of plasma levels achieved with 1 mg dosing, intracellular entecavir-TP levels would be expected to surpass those needed to inhibit the enzyme activity of lamivudine-resistant HBV polymerases. Recombinant viruses encoding adefovir-resistant substitutions at either rtN236T or rtA181V remained fully susceptible to entecavir.

Clinical resistance

Genotyping was performed on paired baseline and on-treatment samples from all continuously treated patients with PCR detectable HBV DNA (≥ 300 copies/mL) at Week 48, 96, 144, 192 and 240 or at the end of dosing to identify any novel or known resistance substitutions that emerged during entecavir therapy. Virologic breakthrough ($\geq 1 \log_{10}$ increase above nadir in HBV DNA by PCR) due to resistance to entecavir requires the existence of primary lamivudine resistance substitutions (M204I/V \pm L180M) along with an additional substitution at residues T184, S202 and/or M250 of the polymerase protein.

Nucleoside-naïve studies

Patients in nucleoside-naïve studies received 0.5 mg entecavir for up to 96 weeks (see Clinical trials, below). Study participants who failed to achieve the study-defined complete response by Week 96 were offered continued entecavir monohydrate treatment in a rollover study. Complete response for HBeAg positive was < 0.7 MEq/mL (approximately 7×10^5 copies/mL) serum HBV DNA and HBeAg loss and, for HBeAg negative, was < 0.7 MEq/mL HBV DNA and ALT normalisation.

By Week 96, evidence of emerging amino acid substitution rtS202G with rtM204V and rtL180M was detected in the HBV of 2 subjects and 1 of them experienced virologic rebound ($\geq 1 \log_{10}$ increased above nadir). In addition, emerging amino acid substitution at rtM204I/V and rtL180M, rtL80I or rtV173L, which conferred decreased phenotypic susceptibility to entecavir in the absence of rtT184, rtS202 or rtM250 changes, were detected in the HBV of 3 subjects who experienced virologic rebound.

Results in **Table 7** reflect use of a 1 mg dose of entecavir for 147 of 149 patients in Year 3 and 121 patients in Year 4, 108 patients in Year 5 and of combination entecavir plus lamivudine therapy (followed by long-term entecavir monotherapy) for a median of 20 weeks for 130 of 149 patients in Year 3 and for 1 week for 1 of 121 patients in Year 4 in the rollover study. Through Week 240 in nucleoside-naïve studies, genotypic evidence of ETVr substitutions at rtT184, rtS202 or rtM250 was identified in 3 patients treated with entecavir, 2 of whom experienced virologic breakthrough (see **Table 7**). These substitutions were observed only in the presence of LVD^r substitutions (rtM204V and rtL180M).

Table 7. Genotypic Resistance to Week 240, Nucleoside-Naïve Patients.

	Year 1	Year 2	Year 3 ^a	Year 4 ^a	Year 5 ^a
Patients treated and monitored for resistance ^b	663	278	149	121	108
Patients in specific year with:					
emerging genotypic entecavir resistance ^c	1	1	1	0	0
genotypic entecavir resistance ^c with virologic breakthrough ^d	1	0	1	0	0
Cumulative probability of:					
emerging genotypic entecavir resistance ^c	0.2%	0.5%	1.2%	1.2%	1.2%
genotypic entecavir resistance ^c with virologic breakthrough ^d	0.2%	0.2%	0.8%	0.8%	0.8%

- a Results reflect use of a 1 mg dose of entecavir monohydrate for 147 patients in Year 3 and all patients in Years 4 and 5 and of combination of entecavir-lamivudine therapy (followed by long-term entecavir therapy) for a median of 20 weeks for 130 patients in Year 3 and for 1 week for 1 patient in Year 4 in a rollover study.
- b Includes patients with at least one on-therapy HBV DNA measurement by PCR at or after Week 24 through Week 58 (Year 1), after Week 58 through Week 102 (Year 2), after Week 102 through Week 156 (Year 3), after Week 156 through Week 204 (Year 4) or after Week 204 through Week 252 (Year 5).
- c Entecavir resistance substitutions at residues rtT184, rtS202 or rtM250. Patients also have lamivudine resistance substitutions (rtM204V and rtL180M).
- d $\geq 1 \log_{10}$ increase above nadir in HBV DNA by PCR, confirmed with successive measurements or at the end of the windowed time point.

Lamivudine-refractory studies

Participants treated with entecavir 1 mg once daily in lamivudine-refractory studies (see Clinical trials, below) who failed to achieve the study-defined complete response by Week 96 were offered continued entecavir treatment in a rollover study. Participants received 1 mg entecavir once daily for up to an additional 96 weeks. Genotypic analysis of clinical samples from lamivudine-refractory patients identified emerging entecavir resistance substitutions in 11/187 patients in Year 1, 12/146 patients in Year 2, 16/80 patients in Year 3, 6/52 patients in Year 4 and 2/33 patients in Year 5 (see **Table 8**). Results in **Table 8** reflect the use of combination entecavir plus lamivudine therapy (followed by long-term entecavir monotherapy) for a median of 13 weeks for 48 of 80 patients in Year 3, for a median of 38 weeks for 10 of 52 patients in Year 4 and for 16 weeks for 1 of 33 patients in Year 5 in the rollover study. The presence of entecavir resistance substitutions at baseline in isolates from 10 (5%) of 187 lamivudine-refractory patients indicates that prior lamivudine treatment can select these resistance substitutions and that they can exist at a low frequency before entecavir treatment. Three of the 10 patients experienced virologic breakthrough in the 240 weeks of follow-up.

Table 8. Genotypic Entecavir Resistance to Week 240, Lamivudine-Refractory Patients

	Year 1	Year 2	Year 3 ^a	Year 4 ^a	Year 5 ^a
Patients treated and monitored for resistance ^b	187	146	80	52	33
Patients in specific year with:					
emerging genotypic entecavir resistance ^c	11	12	16	6	2
genotypic entecavir resistance ^c with virologic breakthrough ^d	2 ^e	14 ^e	13 ^e	9 ^e	1 ^e
Cumulative probability of:					
emerging genotypic entecavir resistance ^c	6%	15%	36%	47%	51%
genotypic entecavir resistance ^c with virologic breakthrough ^d	1% ^e	11% ^e	27% ^e	41% ^e	44% ^e

- a Results reflect use of combination entecavir-lamivudine therapy (followed by long-term entecavir therapy) for a median of 13 weeks for 48 patients in Year 3, a median of 38 weeks for 10 patients in Year 4 and for 16 weeks in 1 patient in Year 5 in a rollover study.
- b Includes patients with at least one on-therapy HBV DNA measurement by PCR at or after Week 24 through Week 58 (Year 1), after Week 58 through Week 102 (Year 2), after Week 102 through Week 156 (Year 3), after Week 156 through Week 204 (Year 4) or after Week 204 through Week 252 (Year 5).
- c Entecavir resistance substitutions at residues rtT184, rtS202 or rtM250. Patients also had lamivudine resistance substitutions (rtM204V/I ± rtL180M).
- d ≥1 log₁₀ increase above nadir in HBV DNA by PCR, confirmed with successive measurements or at the end of the windowed time point.
- e Entecavir resistance substitutions occurring in any year; virologic breakthrough in specified year.

Clinical trials

The safety and efficacy of entecavir were evaluated in three active-controlled trials on five continents. These studies included 1,633 patients 16 years of age or older with chronic hepatitis B infection (serum HBsAg-positive for at least 6 months) accompanied by evidence of viral replication (detectable serum HBV DNA, as measured by the bDNA hybridization or PCR assay). Patients had persistently elevated ALT levels ≥ 1.3 times the upper limit of normal (ULN) and chronic inflammation on liver biopsy compatible with a diagnosis of chronic viral hepatitis. The safety and efficacy of entecavir monohydrate were also evaluated in an active-controlled study of 191 HBV-infected patients with decompensated liver disease and in a study of 68 patients co-infected with HBV and HIV.

Nucleoside-naïve patients with compensated liver disease

Outcomes at 48 weeks

HBeAg-positive

Study AI463022 was a multinational, randomized, double-blind study of entecavir 0.5 mg once daily versus lamivudine 100 mg once daily for 52 weeks in 709 (of 715 randomized) nucleoside-naïve patients with chronic hepatitis B infection and detectable HBeAg. The mean age of patients was 35 years (range: 16–78) and 75% were male; 57% were Asian, 40% were Caucasian and 13% had previously received interferon-α treatment. At baseline, patients had a mean Knodell Necroinflammatory Score of 7.8, mean serum HBV DNA level as measured by Roche COBAS Amplicor®PCR assay of 9.66 log₁₀ copies/mL and mean serum ALT level of 143 U/L. Response was assessed at Week 52 based on test results

obtained at the Week 48 visit. Ninety-six percent of patients had a baseline liver biopsy, paired samples were collected for 89% of patients.

HBeAg-negative (anti-HBe positive/HBV DNA positive)

Study AI463027 was a multinational, randomized, double-blind study of entecavir 0.5 mg once daily versus lamivudine 100 mg once daily for 52 weeks in 638 (of 648 randomized) nucleoside-naïve patients with HBeAg-negative (HBeAb-positive) chronic hepatitis B infection (presumed to have pre-core or core-promoter mutants). The mean age of patients was 44 years (range: 18–77) and 76% were male. Thirty-nine percent were Asian and 58% were Caucasian; 13% had previously received interferon- α treatment. At baseline, patients had a mean Knodell Necroinflammatory Score of 7.8, mean serum HBV DNA level as measured by Roche COBAS Amplicor PCR assay of 7.58 log₁₀ copies/mL and mean serum ALT level of 142 U/L. Ninety-eight percent of patients had a baseline liver biopsy and 89% had a biopsy at Week 48; paired samples were collected for 88% of patients. Response was assessed at Week 52 based on test results obtained at the Week 48 visit. In Studies AI463022 and AI463027, entecavir was superior to lamivudine on the primary efficacy endpoint of Histologic Improvement, defined as ≥ 2 -point reduction in Knodell Necroinflammatory Score with no worsening in Knodell Fibrosis Score at Week 48. Histologic Improvement and change in Ishak Fibrosis Score are shown in **Table 9**. Biochemical, virologic and serologic outcome measures are shown in **Table 10**.

Table 9. Histologic Improvement and Change in Ishak Fibrosis Score at Week 48, Nucleoside-Naïve Patients in Studies AI463022 and AI463027

	Study AI463022 (HBeAg-Positive)			Study AI463027 (HBeAg-Negative)		
	entecavir 0.5 mg (n = 314) ^a	lamivudine 100 mg (n = 314) ^a	Difference entecavir- lamivudine (95% CI) ^b	entecavir 0.5 mg (n = 296) ^a	lamivudine 100 mg (n = 287) ^a	Difference entecavir- lamivudine (95% CI) ^b
Histologic Improvement (Knodell Scores)						
Improvement ^c	72%	62%	9.9% ^d	70%	61%	9.6% ^e
No improvement	21%	24%	(2.6%, 17.2%)	19%	26%	(2.0%, 17.3%)
Ishak Fibrosis Score^f						
Improvement ^f	39%	35%	3.2% ^g	36%	38%	-1.8% ^g
No change	46%	40%	(-4.4%, 10.7%)	41%	34%	(-9.7%, 6.0%)
Worsening ^f	8%	10%		12%	15%	
Missing Week 48 biopsy	7%	14%		10%	13%	

a Patients with evaluable baseline histology (baseline Knodell Necroinflammatory Score ≥ 2).

b In these analyses, missing or inadequate biopsies at Week 48 were classified “no improvement.”

c ≥ 2 -point decrease in Knodell Necroinflammatory Score from baseline with no worsening of the Knodell Fibrosis Score.

d $p < 0.01$.

e $p < 0.05$.

f For Ishak Fibrosis Score, improvement = ≥ 1 -point decrease from baseline and worsening = ≥ 1 -point increase from baseline.

g Not significant.

CI = confidence interval.

Table 10. Biochemical, Virologic and Serologic Endpoints at Week 48, Nucleoside-Naïve Patients in Studies AI463022 and AI463027

	Study AI463022 (HBeAg-Positive)			Study AI463027 (HBeAg-Negative)		
	entecavir 0.5 mg (n = 354)	lamivudine 100 mg (n = 355)	Difference entecavir- lamivudine (95% CI)	entecavir 0.5 mg (n = 325)	lamivudine 100 mg (n = 313)	Difference entecavir- lamivudine (95% CI)
ALT normalisation (≤ 1× ULN)	68%	60%	8.4% ^a (1.3%, 15.4%)	78%	71%	6.9% ^a (0.2%, 13.7%)
HBV DNA Mean change from baseline by PCR ^b (log ₁₀ copies/mL)	-6.86	-5.39	-1.52 ^c (-1.8, -1.3)	-5.04	-4.53	-0.43 ^c (-0.6,-0.3)
Proportion undetectable (< 300 copies/mL) by PCR ^{b,d}	67%	36%	30.3% ^c (23.3%, 37.3%)	90%	72%	18.3% ^c (12.3%, 24.2%)
< 0.7 MEq/mL by bDNA ^e	91%	65%	25.6% ^c (19.8%, 31.4%)	95%	89%	5.9% ^f (1.8%, 10.1%)
Loss of HBeAg	22%	20%		N/A	N/A	
HBeAg seroconversion	21%	18%		N/A	N/A	

a p < 0.05.

b Roche COBAS Amplicor PCR assay.

c p < 0.0001.

d At Week 24, HBV DNA < 300 copies/mL by PCR was observed in 42% of entecavir-treated patients and 25% of lamivudine-treated patients (p < 0.0001) in Study AI463022 and 74% of entecavir-treated patients and 62% of lamivudine-treated patients (p = 0.0013) in Study AI463027.

e Quantiplex bDNA assay.

f p < 0.01.

CI = confidence interval.

Responses for patients with baseline Knodell Fibrosis Scores of 4 (cirrhosis) were comparable to overall responses on all efficacy outcome measures (all patients had compensated liver disease). Histologic Improvement was independent of baseline HBV DNA or ALT levels.

Covalently closed circular deoxyribonucleic acid (cccDNA) is a stable genomic form of nuclear HBV DNA that serves as an hepatic reservoir of virus, provides the template for HBV transcription and contributes to viral persistence and relapse. For a subset of patients with paired liver samples in Study AI463022, the mean change from baseline in hepatic cccDNA at Week 48 was -0.9 log₁₀ copies/human genome equivalents (approximately 8-fold reduction) for entecavir-treated patients (n = 159) and -0.7 log₁₀ copies/HGEq (approximately 5-fold reduction) for lamivudine-treated patients (n = 146). In Study AI463027, the mean change from baseline in hepatic cccDNA at Week 48 was -0.5 log₁₀ copies/HGEq (approximately 3-fold reduction) in each treatment group (n = 107 for entecavir-treated patients and n = 104 for lamivudine-treated patients).

Lamivudine-refractory patients

Outcomes at 48 weeks

Study AI463026 was a multinational, randomized, double-blind study of entecavir in 286 (of 293 randomized) patients with lamivudine-refractory chronic hepatitis B infection. Patients receiving lamivudine at study entry either switched to entecavir 1 mg once daily (with neither a washout nor an overlap period) or continued on lamivudine 100 mg for 52 weeks. The mean age of patients was 39 years (range: 16–74), and 76% were male; 37% were Asian and 62% were Caucasian. Eighty-five percent had LVD^R mutations at baseline. Patients had a mean Knodell Necroinflammatory Score of 6.5, mean serum HBV DNA level as measured by Roche COBAS Amplicor PCR assay of 9.36 log₁₀ copies/mL and mean serum ALT level of 128 U/L. Response was assessed at Week 52 based on test results obtained at the Week 48 visit. Ninety-eight percent of patients had a baseline liver biopsy and 88% had a biopsy at Week 48; paired samples were collected for 87% of patients.

In Study AI463026, entecavir was superior to lamivudine on the coprimary endpoints of Histologic Improvement (using the Knodell Score at Week 48) and Composite Endpoint (proportion of patients with HBV DNA < 0.7 MEq/mL by bDNA assay and ALT < 1.25x ULN at Week 48). These results and change in Ishak Fibrosis Score are shown in **Table 11**. **Table 12** shows biochemical, virologic and serologic endpoints.

Table 11. Histologic Improvement, Change in Ishak Fibrosis Score and Composite Endpoint at Week 48, Lamivudine-Refractory Patients in Study AI463026^a

	Entecavir 1 mg (n =124) ^a	Lamivudine 100 mg (n =116) ^a	Difference Entecavir-Lamivudine (97.5% CI)
Histologic Improvement (Knodell Scores)			
Improvement ^b	55%	28%	27.3% ^{c,d} (13.6%, 40.9%)
No improvement	34%	57%	
Ishak Fibrosis Score^e			
Improvement ^e	34%	16%	17.5% ^{c,f} (6.8%, 28.2%) ^g
No change	44%	42%	
Worsening ^e	11%	26%	
Missing Week 48 biopsy	11%	16%	
Composite Endpoint^h			
	n =141 55%	n =145 4%	50.5% ^d (40.4%, 60.6%)

a Patients with evaluable baseline histology (baseline Knodell Necroinflammatory Score ≥ 2).

b ≥ 2-point decrease in Knodell Necroinflammatory Score from baseline with no worsening of the Knodell Fibrosis Score.

c In this analysis, missing or inadequate biopsies at Week 48 were classified “no improvement”.

d p < 0.0001.

e For Ishak Fibrosis Score, improvement = ≥ 1-point decrease from baseline and worsening = ≥ 1-point increase from baseline.

f p < 0.01.

g 95% confidence interval.

h Composite Endpoint (a coprimary endpoint) was defined as HBV DNA < 0.7 MEq/mL by bDNA assay and normalisation of serum ALT (< 1.25x ULN) at Week 48.

CI = confidence interval

Table 12. Biochemical, Virologic and Serologic Endpoints at Week 48, Lamivudine-Refractory Patients in Study AI463026

	Entecavir 1 mg (n =141)	Lamivudine 100 mg (n =145)	Difference Entecavir-Lamivudine (95% CI)
ALT normalisation ($\leq 1 \times$ ULN)	61%	15%	45.8% ^a (35.9%, 55.8%)
HBV DNA Mean change from baseline by PCR ^b (log ₁₀ copies/mL)	-5.11	-0.48	-4.39 ^a (-4.8, -4.0)
Proportion undetectable (< 300 copies/mL) by PCR ^{b,c}	19%	1%	17.8% ^a (11.0%, 24.5%)
< 0.7 MEq/mL by bDNA ^d	66%	6%	60.4% ^a (51.8%, 69.1%)
Loss of HBeAg	10%	3%	
HBeAg seroconversion	8%	3%	

a $p < 0.0001$.

b Roche COBAS Amplicor PCR assay.

c At Week 24, HBV DNA < 300 copies/mL by PCR was observed in 7% of entecavir-treated patients and no lamivudine-treated patients ($p = 0.0011$).

d Quantiplex bDNA assay.

CI = confidence interval.

In Study AI463026, responses for patients with baseline Knodell Fibrosis Scores of 4 (cirrhosis) were comparable to overall responses on all efficacy outcome measures (all patients had compensated liver disease). Histologic Improvement was independent of baseline HBV DNA or ALT levels.

For a subset of patients with paired liver samples in Study AI463026, the mean change from baseline in hepatic cccDNA at Week 48 was $-0.6 \log_{10}$ copies/HGEq (approximately 4-fold reduction) for entecavir-treated patients ($n = 74$) and $0.0 \log_{10}$ copies/HGEq for lamivudine-treated patients ($n = 59$).

Health-related quality of life (HRQoL) was assessed in Study AI463026 using the standardized and validated EQ-5D instrument developed by the EuroIQoL group. After 48 weeks of therapy, entecavir-treated patients experienced significantly less worsening compared to lamivudine-treated patients in the dimensions of mobility, self care and pain/discomfort.

Outcomes beyond 48 weeks

The optimal duration of therapy with entecavir is unknown. According to protocol mandated criteria in the Phase 3 clinical trials, participants discontinued entecavir or lamivudine treatment after 52 weeks according to a definition of response based on HBV virologic suppression (< 0.7 mEq/mL by bDNA assay) and either loss of HBeAg in HBeAg-positive participants or ALT < 1.25x ULN in HBeAg-negative participants at Week 48. Participants who achieved virologic suppression but did not have serologic response (HBeAg-positive) or did not achieve ALT < 1.25x ULN (HBeAg-negative) continued blinded dosing until 96 weeks or until the response criteria were met. These protocol-specific participant management guidelines are not intended as guidance for clinical practice.

Nucleoside-naïve HBeAg-positive

Among nucleoside-naïve HBeAg-positive participants (Study AI463022), 243/354 (69%) entecavir-treated participants and 164/355 (46%) lamivudine-treated participants continued blinded treatment for up to 96 weeks. Of those continuing blinded treatment in Year 2, 180/243 (74%) entecavir-treated participants and 60/164 (37%) lamivudine-treated participants achieved HBV DNA < 300 copies/mL by PCR at the end of dosing; 193/243 (79%) entecavir-treated participants achieved ALT ≤ 1× ULN compared to 112/164 (68%) lamivudine-treated participants. The number of participants with virologic response but not serologic response who achieved a loss of HBeAg at the end of dosing in the second year of blinded treatment was 37/243 (15%) for entecavir and 28/164 (17%) for lamivudine. The proportion who achieved HBeAg seroconversion was 26/243 (11%) for entecavir and 20/164 (12%) for lamivudine.

Post-treatment follow-up: Among nucleoside-naïve HBeAg-positive participants, 111/354 (31%) entecavir-treated participants and 93/355 (26%) lamivudine-treated participants met the definition of response at end of dosing, discontinued study drugs and were followed off-treatment for up to 24 weeks. In this cohort, 34/111 (31%) entecavir-treated patients and 27/93 (29%) lamivudine-treated patients had HBV DNA < 300 copies/mL by PCR at the end of follow-up. At the end of follow-up, 78/111 (70%) of the entecavir group and 59/93 (63%) of the lamivudine group recorded ALT ≤ 1× ULN.

Nucleoside-naïve HBeAg-negative

Among nucleoside-naïve, HBeAg-negative participants (Study AI463027), 26/325 (8%) entecavir-treated participants and 28/313 (9%) lamivudine-treated participants continued blinded treatment for up to 96 weeks. In the cohorts continuing treatment, 22/26 entecavir-treated and 16/28 lamivudine-treated participants had HBV DNA < 300 copies/mL by PCR; 7 entecavir-treated and 6 lamivudine-treated patients had ALT ≤ 1× ULN at the end of dosing (up to 96 weeks).

Post-treatment follow-up: Among the nucleoside-naïve, HBeAg-negative participants, 286/325 (88%) treated with entecavir and 253/313 (81%) treated with lamivudine met the definition of response at end of dosing, discontinued study drugs and were followed off-treatment for up to 24 weeks. In this cohort, 7/286 (2%) entecavir-treated patients and 10/253 (4%) lamivudine-treated patients had HBV DNA < 300 copies/mL by PCR at the end of follow-up. At the end of follow-up 129/286 (45%) in the entecavir group and 85/253 (34%) in the lamivudine group recorded ALT ≤ 1× ULN.

Liver biopsy results: 57 patients from the pivotal nucleoside-naïve studies AI463022 (HBeAg positive) and AI463027 (HBeAg negative) who enrolled in a long-term rollover study were evaluated for long-term liver histology outcomes. All 57 patients had both an evaluable baseline and long-term biopsy, with a median duration of entecavir therapy of 280 weeks (approximately 6 years). 55 of 57 (96%) of these patients had Histologic Improvement (a ≥ 2-point decrease in Knodell necroinflammatory score from baseline with no worsening of the Knodell fibrosis score) and 50 of 57 (88%) had a ≥ 1-point decrease in Ishak fibrosis score. Of the 43 patients with a baseline Ishak fibrosis score of ≥ 2, 25 (58%) had a ≥ 2-point decrease. All (10/10) patients with advanced fibrosis or cirrhosis at baseline (Ishak fibrosis score of 4.5 or 6) had a ≥ 1-point decrease (median decrease from baseline of 1.5 points). At the time of the long-term biopsy, 57 (100%) of patients had HBV DNA < 300 copies/mL and 49 (86%) had serum ALT ≤ 1× ULN.

Lamivudine-refractory: Among lamivudine-refractory participants (Study AI463026), 77/141 (55%) in the entecavir-treated group and 3/145 (2%) in the lamivudine-treated group continued blinded treatment for up to 96 weeks. In the entecavir-treated cohort, 31/77 (40%) achieved HBV DNA < 300 copies/mL, 62/77 (81%) had ALT ≤ 1× ULN and 8/77 (10%) demonstrated HBeAg seroconversion at the end of dosing.

Post-treatment follow-up: Of the 22/141 (16%) lamivudine-refractory patients who met response criteria (HBV DNA < 0.7 mEq/mL on bDNA assay and loss of HBeAg) while receiving entecavir monohydrate, 5/22 (23%) had HBV DNA < 300 copies/mL by PCR and 12/22 (55%) had ALT ≤ 1× ULN at the end of follow-up.

Special populations

Patients with decompensated liver disease

Study **AI463048** was a randomized, open-label study of entecavir versus adefovir dipivoxil in 191 (of 195 randomised) patients with HBeAg-positive or -negative chronic HBV infection and evidence of hepatic decompensation, defined as Child-Turcotte-Pugh (CTP) score of 7 or higher. Patients were either HBV-treatment naïve or pre-treated (excluding pre-treatment with entecavir, adefovir dipivoxil or tenofovir disoproxil fumarate). At baseline, patients had a mean serum HBV DNA by PCR of 7.83 log₁₀ copies/mL and mean ALT level of 100 U/L; 54% of patients were HBeAg-positive; 35% had genotypic evidence of lamivudine resistance. The baseline mean CTP score was 8.6. The dose of entecavir monohydrate in this study was 1 mg once daily. Entecavir was superior to adefovir dipivoxil on the primary efficacy endpoint of mean change from baseline in serum HBV DNA by PCR at Week 24. Results for selected study endpoints at Weeks 24 and 48 are shown in **Table 13**.

Table 13. Selected Endpoints at Weeks 24 and 48, Patients with Decompensated Liver Disease, Study AI463048.

	Week 24		Week 48	
	Entecavir 1 mg (n = 100)	Adefovir dipivoxil 10 mg (n = 91)	Entecavir 1 mg (n = 100)	Adefovir dipivoxil 10 mg (n = 91)
HBV DNA ^a				
Proportion undetectable (< 300 copies/mL)	49%*	16%	57%*	20%
Mean change from baseline (log ₁₀ copies/mL)	-4.48*	-3.40	-4.66	-3.90
Stable or improved CTP score ^b	66%	71%	61%	67%
Model for End-Stage Liver Disease (MELD) score	-2.0	-0.9	-2.6	-1.7
Mean change from baseline ^c				
HBsAg loss	1%	0	5%	0
Normalisation of: ^d				
ALT (≤ 1× ULN)	46/78 (59%)*	28/71 (39%)	49/78 (63%)*	33/71 (46%)
Albumin (≥ 1× LLN)	20/82 (24%)	14/69 (20%)	32/82 (39%)	20/69 (29%)
Bilirubin (≤ 1× ULN)	12/75 (16%)	10/65 (15%)	15/75 (20%)	18/65 (28%)
Prothrombin time (≤ 1× ULN)	9/95 (9%)	6/82 (7%)	8/95 (8%)	7/82 (9%)

a Roche COBAS Amplicor PCR assay (LLOQ = 300 copies/mL).

b Defined as decrease or no change from baseline in CTP score.

c Baseline mean MELD score was 17.1 for entecavir and 15.3 for adefovir dipivoxil.

d Denominator is patients with abnormal values at baseline.

* p < 0.05.

ULN = upper limit of normal, LLN = lower limit of normal.

HIV/HBV co-infected patients

Study **AI463038** was a randomized, double-blind, placebo-controlled study of entecavir versus placebo in 68 patients co-infected with HIV and HBV who were lamivudine refractory [experienced recurrence of HBV viremia while receiving a lamivudine-containing HAART (highly active antiretroviral therapy) regimen]. Patients continued their lamivudine-containing HAART regimen (lamivudine dose 300 mg/day) and were assigned to add either entecavir 1 mg once daily (51 patients) or placebo (17 patients) for 24 weeks followed by an open-label phase for an additional 24 weeks where all patients received entecavir. At baseline, patients had a mean serum HBV DNA level by PCR of 9.13 log₁₀ copies/mL. Most patients were HBeAg-positive at baseline, with a mean baseline ALT level of 71.5 U/L. Biochemical and virologic endpoints at Week 24 are shown in **Table 14**.

Table 14. Biochemical and Virologic Endpoints at Week 24, Study AI463038

	Entecavir 1 mg ^a (n = 51)	Placebo ^a (n = 17)	Difference Entecavir-Placebo (95% CI)
HBV DNA (by PCR assay ^b)			
Proportion undetectable (< 300 copies/mL)	3/51 (6%)	0	5.9% (-0.6, 12.3)
Mean change from baseline (log ₁₀ copies/mL)	-3.65 (n = 48)	+0.11 (n = 16)	-3.75 ^c (-4.47, -3.04)
ALT normalisation (≤1× ULN)	12/35 (34%)	1/12 (8%)	26.0 ^d (3.8, 48.1)

a All patients also received a lamivudine-containing HAART regimen.

b Roche COBAS AmpliCor PCR assay.

c p < 0.0001.

d p = 0.08.

At the end of the open-label phase (Week 48), the mean change from baseline HBV DNA by PCR for patients originally assigned to entecavir was -4.20 log₁₀ copies/mL (n = 43); 4/51 (8%) patients had HBV DNA < 300 copies/mL by PCR; and 13/35 (37%) patients with abnormal ALT at baseline had ALT normalisation. Entecavir has not been evaluated in HIV/HBV co-infected patients who are not concurrently receiving effective HIV treatment (see Section 4.4 Special Warnings and Precautions for Use, Co-infection with HIV).

Liver transplant recipients

The safety and efficacy of entecavir 1 mg once daily were assessed in a single-arm, open label study in 65 patients who received a liver transplant for complications of chronic HBV infection and had HBV DNA < 172 IU/mL (approximately 1000 copies/mL) at the time of transplant. The study population was 82% male, 39% Caucasian and 37% Asian, with a mean age of 49 years; 89% of patients had HBeAg-negative disease at the time of transplant. Of the 61 patients who were evaluable for efficacy (received entecavir for at least 1 month), 60 also received hepatitis B immune globulin as part of the post-transplant prophylaxis regimen. At Week 72 post-transplant, none of the evaluable patients had HBV recurrence [defined as HBV DNA ≥ 50 IU/mL (approximately 300 copies/mL)] by last-observation-carried forward analysis. The frequency and nature of adverse events in this study were consistent with those expected in patients who have received a liver transplant and the known safety profile of entecavir monohydrate.

5.2 PHARMACOKINETIC PROPERTIES

Absorption

In healthy participants, entecavir was rapidly absorbed with peak plasma concentrations occurring between 0.5 and 1.5 hours. There was a dose-proportionate increase in peak plasma concentration (C_{max}) and area under the concentration-time curve (AUC) values following multiple doses ranging from 0.1 to 1 mg. Steady-state was achieved after 6–10 days of once-daily dosing with approximately 2-fold accumulation. C_{max} and trough plasma concentration (C_{trough}) at steady-state were 4.2 and 0.3 ng/mL, respectively, for a 0.5 mg dose and 8.2 and 0.5 ng/mL, respectively, for a 1 mg dose. In healthy participants, the bioavailability of the tablet was 100% relative to the oral solution². The oral solution and tablet may be used interchangeably.

Oral administration of entecavir 0.5 mg with a standard high-fat meal (945 kcal, 54.6 g fat) or a light meal (379 kcal, 8.2 g fat) resulted in a minimal delay in absorption (1–1.5 hour fed vs. 0.75 hour fasted), a decrease in C_{max} of 44–46% and a decrease in AUC of 18–20%. Therefore, entecavir should be administered on an empty stomach (at least 2 hours before a meal and at least 2 hours after a meal) (see Section 4.2 Dose and Method of Administration).

Distribution

The estimated volume of distribution for entecavir was in excess of total body water, suggesting that it has good penetration into tissues. Protein binding to human serum protein *in vitro* was approximately 13%.

Metabolism

Entecavir is not a substrate, inhibitor or inducer of the CYP450 enzyme system. At concentrations approximately 10,000-fold higher than those obtained in humans, entecavir inhibited none of the major human CYP450 enzymes 1A2, 2C9, 2C19, 2D6, 3A4, 2B6 and 2E1. At concentrations approximately 340-fold higher than those observed in humans, entecavir did not induce the human CYP450 enzymes 1A2, 2C9, 2C19, 3A4, 3A5 and 2B6. Following administration of ¹⁴C-entecavir in humans and rats, no oxidative or acetylated metabolites and minor amounts of the phase II metabolites glucuronide and sulfate conjugates were observed.

Excretion

After reaching peak levels, entecavir plasma concentrations decreased in a bi-exponential manner with a terminal elimination half-life of approximately 128–149 hours. The observed drug accumulation index is approximately 2-fold with once-daily dosing, suggesting an effective accumulation half-life of about 24 hours.

Entecavir is predominantly eliminated by the kidney with urinary recovery of unchanged drug at steady-state ranging from 62% to 73% of the dose. Renal clearance is independent of dose and ranges between 360 and 471 mL/min suggesting that entecavir undergoes both glomerular filtration and net tubular secretion.

Special Populations

Gender/race

The pharmacokinetic profile of entecavir monohydrate does not vary by gender or race.

² Entecavir oral solution is unavailable in this brand, however is available in other brands

Elderly

The pharmacokinetic profile of entecavir does not vary by age.

Renal impairment

The pharmacokinetics of entecavir following a single 1 mg dose were studied in patients (without chronic hepatitis B infection) with selected degrees of renal impairment, including patients whose renal impairment was managed by hemodialysis or continuous ambulatory peritoneal dialysis (CAPD). Results are shown in **Table 15**.

Table 15. Pharmacokinetic Parameters of Entecavir in Participants with Selected Degrees of Renal Impairment

	Renal Function Group Baseline Creatinine Clearance (mL/min)					
	Unimpaired > 80 (n = 6)	Mild > 50–≤ 80 (n = 6)	Moderate 30–50 (n = 6)	Severe < 30 (n = 6)	Severe Managed with Hemodialysis (n = 6)	Severe Managed with CAPD (n = 4)
C _{max} (ng/mL) (CV%)	8.1 (30.7)	10.4 (37.2)	10.5 (22.7)	15.3 (33.8)	15.4 (56.4)	16.6 (29.7)
AUC _(0-T) (ng•hr/mL) (CV)	27.9 (25.6)	51.5 (22.8)	69.5 (22.7)	145.7 (31.5)	233.9 (28.4)	221.8 (11.6)
CLR (mL/min) (SD)	383.2 (101.8)	197.9 (78.1)	135.6 (31.6)	40.3 (10.1)	NA	NA
CLT/F (mL/min) (SD)	588.1 (153.7)	309.2 (62.6)	226.3 (60.1)	100.6 (29.1)	50.6 (16.5)	35.7 (19.6)

CLR = renal clearance; CLT/F = apparent oral clearance.

Dosage adjustment is recommended for patients with a creatinine clearance < 50 mL/min, including patients on hemodialysis or CAPD. (see Section 4.2 Dose and Method of Administration, Renal impairment).

Following a single 1 mg dose of entecavir, hemodialysis removed approximately 13% of the entecavir dose over 4 hours and CAPD removed approximately 0.3% of the dose over 7 days. Entecavir should be administered after hemodialysis.

Hepatic impairment

The pharmacokinetics of entecavir following a single 1 mg dose were studied in patients (without chronic hepatitis B infection) with moderate and severe hepatic impairment. The pharmacokinetics of entecavir were similar between hepatically impaired patients and healthy control participants; therefore, no dosage adjustment of entecavir is recommended for patients with hepatic impairment.

Post-liver transplant

Entecavir exposure in HBV-infected liver transplant recipients on a stable dose of cyclosporine A (n = 5) or tacrolimus (n = 4) was approximately 2-fold the exposure in healthy participants with normal renal function. Altered renal function contributed to the increase in entecavir exposure in these patients. Before and during entecavir therapy in liver transplant recipients receiving cyclosporine or tacrolimus, renal function should be carefully evaluated (see Section 4.2 Dose and Method of Administration, Renal impairment).

Paediatrics

Pharmacokinetic studies have not been conducted in children.

Drug interactions

Entecavir is not a substrate, inhibitor or inducer of the CYP450 enzyme system (see Section 5.2 Pharmacokinetic properties, Metabolism & Excretion, above). The pharmacokinetics of entecavir are unlikely to be affected by co-administration with agents that are either metabolized by, inhibit or induce the CYP450 system. Likewise, the pharmacokinetics of known CYP substrates are unlikely to be affected by co-administration of entecavir.

The steady-state pharmacokinetics of entecavir and co-administered drug were not altered in interaction studies of entecavir monohydrate with each of the following:

- lamivudine
- adefovir dipivoxil
- tenofovir disoproxil fumarate (see Section 4.5 Interactions with Other Medicines and Other Forms of Interactions).

A pilot study in nine HBV-infected liver transplant recipients suggested that concurrent ciclosporin A (n = 5) or tacrolimus (n = 4) therapy did not affect the pharmacokinetics of entecavir (see Section 5.1 Pharmacology, Special populations, Post-liver transplant). The effect of entecavir on the pharmacokinetics of ciclosporin A or tacrolimus is unknown.

5.3 PRECLINICAL SAFETY DATA

Genotoxicity

Entecavir was not genotoxic in *in vitro* assays for bacterial gene mutation, cell transformation and DNA repair or in an *in vivo* micronucleus assay for clastogenicity. High concentrations were clastogenic *in vitro* in human lymphocyte (> 10 µg/mL) and mouse L5178Y[±] lymphoma cell (> 28 µg/mL) assays, with evidence that the L5178Y[±] cell response was related to perturbation of cellular deoxyribonucleotide triphosphate pools.

Carcinogenicity

Two-year carcinogenicity studies with entecavir were conducted in mice and rats. In mice, entecavir was administered orally at 4 dosage levels representing exposure multiples of 1, 2.4, 10 and 34 times human exposure at the 1 mg dose. The doses in rats achieved exposure multiples relative to the human 1 mg dose of < 0.3, 0.3, 3.9 and 29 times and 0.3, 0.6, 3.6 and 20 times in males and females, respectively. Increases in the incidence of lung tumours were observed in male and female mice at exposures ≥ 2.4 times that in humans. Mechanistic studies suggest the lung tumours are likely to be species-specific to mice and probably not relevant to humans. In male rats, entecavir caused pancreatic acinar cell hyperplasia and adenomas at ≥ 3.9 times human exposure. An increase in skin fibromas was seen in female rats at ≥ 3.6 times the exposure in humans at 1 mg/day. The incidence of microglial tumours was increased in rats at and above 0.3 times the exposures in humans at 1 mg/day, reaching statistical significance at 20 times human exposure. Other tumours, which were observed only at exposures ≥ 20 times the exposure in humans at 1 mg/day, included hepatocellular adenomas and/or carcinomas (mice, rats), vascular tumours (mice, rats) salivary duct adenocarcinomas (mice), kidney oncocytoma and malignant mesenchymal tumours (rats) and Zymbal's gland carcinomas (rats; no human counterpart). With the exception of the mouse lung tumours, disruption of cellular deoxyribonucleotide triphosphated (dNTP) pools is likely a significant factor in the carcinogenicity of entecavir, which involves a threshold mechanism. These tumours were generally late appearing and required long-term exposure. Based on animal data, an increased risk of cancer in humans treated with entecavir for an extended period cannot be excluded.

6. PHARMACEUTICAL PARTICULARS

6.1 LIST OF EXCIPIENTS

Lactose monohydrate, povidone, crospovidone, microcrystalline cellulose and magnesium stearate. The 0.5 mg tablet coating is OPADRY complete film coating system 13B58802 White (which contains hypromellose, titanium dioxide, macrogol 400 and polysorbate 80). The 1 mg tablet coating is OPADRY complete film coating system 13B84610 Pink (which contains hypromellose, titanium dioxide, macrogol 400, polysorbate 80 and iron oxide red).

6.2 INCOMPATIBILITIES

Incompatibilities were either not assessed or not identified as part of the registration of this medicine.

6.3 SHELF LIFE

In Australia, information on the shelf life can be found on the public summary of the Australian Register of Therapeutic Goods (ARTG). The expiry date can be found on the packaging.

6.4 SPECIAL PRECAUTIONS FOR STORAGE

Store below 25°C. Store in original package.

6.5 NATURE AND CONTENTS OF CONTAINER

lister pack (PA/Al/PVC/Al) of 30s.

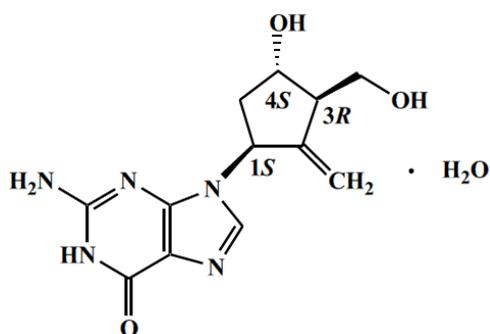
0.5 mg tablets – AUST R 256432; 1 mg tablets – AUST R 256492.

6.6 SPECIAL PRECAUTIONS FOR DISPOSAL

In Australia, any unused medicine or waste material should be disposed of by taking to your local pharmacy.

6.7 PHYSICOCHEMICAL PROPERTIES

Chemical structure



Chemical Name: 2-amino-1,9-dihydro-9- [(1 S,3R,4S)-4-hydroxy-3-(hydroxymethyl)-2-methylenecyclopentyl]-6H-purin-6-one, monohydrate.

Molecular Formula: C₁₂H₁₅N₅O₃•H₂O

Molecular Weight: 295.3

Entecavir monohydrate is a white to off-white powder. It is slightly soluble in water (2.4 mg/mL) and the pH of the saturated solution in water is 7.9 at 25° ± 0.5° C. The partition coefficient log P is -0.81, -1.4 and the pKa in strongest acid is 8 and strongest basic is 2.77.

CAS number

209216-23-9

7 MEDICINE SCHEDULE (POISONS STANDARD)

S4 – Prescription Only Medicine

8 SPONSOR

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9 DATE OF FIRST APPROVAL

19 May 2016

10 DATE OF REVISION

10 May 2019

Summary table of changes

Section(s) changed	Summary of new information
8 all	Sponsor details changed Minor editorial changes