

## COMBIVIR TABLETS

### QUALITATIVE AND QUANTITATIVE COMPOSITION

*COMBIVIR* tablets contain 150 mg lamivudine and 300 mg zidovudine and are white to off-white capsule-shaped, scored tablets, engraved with GX FC3 on both faces.

### PHARMACEUTICAL FORM

Film-coated tablets.

### CLINICAL PARTICULARS

#### Indications

*COMBIVIR* is indicated for the treatment of HIV-infected adults and adolescents > 12 years, with progressive immunodeficiency (CD4+ Count = < 500 cells/mm<sup>3</sup>).

Lamivudine in combination with zidovudine reduces HIV-1 viral load and increases CD4+ cell count. Clinical endpoint data indicate that lamivudine in combination with zidovudine alone, or in combination with zidovudine containing treatment regimens result in a significant reduction in the risk of disease progression and mortality.

#### Dosage and Administration

*COMBIVIR* therapy should be initiated and monitored by a physician experienced in the management of HIV infection.

*COMBIVIR* may be administered with or without food.

Adults and children over the age of 12 years:

The recommended dose of *COMBIVIR* is one tablet twice daily.

If a reduction in dose of *COMBIVIR* appears clinically indicated, or if one of the components of *COMBIVIR* (lamivudine or zidovudine) requires reduction or discontinuation, separate preparations of lamivudine (*EPIVIR*<sup>TM</sup>) and zidovudine (*RETROVIR*<sup>TM</sup>) are available in tablets/capsules and oral solution.

- **Elderly**

No specific data are available, however special care is advised in this age group due to age associated changes such as the decrease in renal function and alteration of haematological parameters.

- **Renal impairment**

Dosage adjustment of lamivudine is required in patients with a creatinine clearance of less than 50 ml/min (*see Pharmacokinetics*). It is therefore recommended that separate preparations of lamivudine and zidovudine should be administered to these patients.

- **Hepatic impairment**

Dosage adjustments for zidovudine may be necessary in patients with hepatic impairment (*see Pharmacokinetics*). It is therefore recommended that separate preparations of lamivudine and zidovudine should be administered to patients with severe hepatic impairment.

- **Dosage adjustments in patients with haematological adverse reactions**

Dosage adjustment of zidovudine may be necessary if the haemoglobin level falls below 9 g/dl or 5.59 mmol/l or the neutrophil count falls below  $1.0 \times 10^9/l$  (*see Contraindications and Warnings and Precautions*). As dosage adjustment of *COMBIVIR* is not possible, separate preparations of zidovudine and lamivudine should be used. Physicians should refer to the individual prescribing information for these drugs.

## **Contraindications**

The use of *COMBIVIR* is contra-indicated in patients with known hypersensitivity to lamivudine, zidovudine or to any ingredient of the preparation.

Zidovudine is contra-indicated in patients with abnormally low neutrophil counts (less than  $0.75 \times 10^9/l$ ), or abnormally low haemoglobin levels (less than 7.5 g/dl or 4.65 mmol/l). *COMBIVIR* is therefore contra-indicated in these patients (*see Warnings and Precautions*).

## **Warnings and Precautions**

The special warnings and precautions relevant to both lamivudine and zidovudine are included in this section. There are no additional precautions and warnings relevant to the combination *COMBIVIR*.

It is recommended that separate preparations of lamivudine and zidovudine should be administered in cases where dosage adjustment is necessary. In these cases the physician should refer to the individual prescribing information for these medicinal products.

Patients should be cautioned about the concomitant use of self-administered medications (*see Interactions*).

Patients should be advised that current antiretroviral therapy, including *COMBIVIR*, has not been proven to prevent the risk of transmission of HIV to others through sexual contact or blood contamination. Appropriate precautions should continue to be taken.

Patients treated with *COMBIVIR* or any other antiretroviral therapy may continue to develop opportunistic infections and other complications of HIV infection. Therefore

patients should remain under close clinical observation by physicians experienced in the treatment of HIV infection.

- **Haematological adverse reactions**

Anaemia, neutropenia and leucopenia (usually secondary to neutropenia) can be expected to occur in patients receiving zidovudine. These occurred more frequently at higher zidovudine dosages (1200-1500 mg/day), in patients with advanced HIV disease and in those who had poor marrow reserve prior to treatment (*see Adverse Reactions*).

Haematological parameters should therefore be carefully monitored (*see Contraindications*) in patients receiving *COMBIVIR*.

These haematological effects are not usually observed before four to six weeks therapy. For patients with advanced symptomatic HIV disease, it is generally recommended that blood tests are performed at least every two weeks for the first three months of therapy and at least monthly thereafter. In patients with early HIV disease, haematological adverse reactions are infrequent. Depending on the overall condition of the patient, blood tests may be performed less often, for example every one to three months.

Additionally dosage adjustment of zidovudine may be required if severe anaemia or myelosuppression occurs during treatment with *COMBIVIR*, or in patients with pre-existing bone marrow compromise for example haemoglobin less than 9 g/dl (5.59 mmol/l) or neutrophil count less than  $1.0 \times 10^9/l$ . As dosage adjustment of *COMBIVIR* is not possible, separate preparations of zidovudine and lamivudine should be used (*see Contraindications*).

- **Children**

Combivir is not indicated for children less than 12 years old as appropriate dose reduction for the weight of the child cannot be made.

- **Pancreatitis**

Cases of pancreatitis have occurred rarely in patients treated with lamivudine and zidovudine. However it is not clear whether these cases were due to treatment with the medicinal products or to the underlying HIV disease. Pancreatitis must be considered whenever a patient develops abdominal pain, nausea, vomiting or elevated biochemical markers. Discontinue use of *COMBIVIR* until diagnosis of pancreatitis is excluded.

- **Lactic Acidosis/severe hepatomegaly with steatosis**

Lactic acidosis and severe hepatomegaly with steatosis, including fatal cases, have been reported with the use of antiretroviral nucleoside analogues either alone or in combination, including lamivudine and zidovudine. A majority of these cases have been in women.

Clinical features which may be indicative of the development of lactic acidosis include generalised weakness, anorexia and sudden unexplained weight loss, gastrointestinal symptoms and respiratory symptoms (dyspnoea and tachypnoea).

Caution should be exercised when administering *COMBIVIR* particularly those with known risk factors for liver disease. Treatment with *COMBIVIR* should be suspended in any patient who develops clinical or laboratory findings suggestive of lactic acidosis or pronounced hepatotoxicity (which may include hepatomegaly and steatosis even in the absence of marked transaminase elevations).

- **Lipoatrophy**

Treatment with zidovudine has been associated with loss of subcutaneous fat. The incidence and severity of lipoatrophy are related to cumulative exposure. This fat loss, which is most evident in the face, limbs and buttocks, may be only partially reversible and improvement may take several months when switching to a zidovudine-free regimen. Patients should be regularly assessed for signs of lipoatrophy during therapy with *COMBIVIR* and other zidovudine containing products (Retrovir and Trizivir), and if feasible therapy should be switched to an alternative regimen if there is suspicion of lipoatrophy development.

- **Serum lipids and blood glucose**

Serum lipid and blood glucose levels may increase during antiretroviral therapy. Disease control and life style changes may also be contributing factors. Consideration should be given to the measurement of serum lipids and blood glucose. Lipid disorders should be managed as clinically appropriate.

- **Immune Reconstitution Syndrome**

In HIV-infected patients with severe immune deficiency at the time of initiation of anti-retroviral therapy (ART), an inflammatory reaction to asymptomatic or residual opportunistic infections may arise and cause serious clinical conditions, or aggravation of symptoms. Typically, such reactions have been observed within the first few weeks or months of initiation of ART. Relevant examples are cytomegalovirus retinitis, generalised and/or focal mycobacterial infections and *Pneumocystis jiroveci* pneumonia (often referred to as PCP). Any inflammatory symptoms must be evaluated without delay and treatment initiated when necessary. Autoimmune disorders (such as Graves' disease, polymyositis and Guillain-Barre syndrome) have also been reported to occur in the setting of immune reconstitution, however, the time to onset is more variable, and can occur many months after initiation of treatment and sometimes can be an atypical presentation.

- **Patients co-infected with Hepatitis B virus**

Clinical trial and marketed use of lamivudine, have shown that some patients with chronic hepatitis B virus (HBV) disease may experience clinical or laboratory evidence of recurrent hepatitis upon discontinuation of lamivudine, which may have more severe consequences in patients with decompensated liver disease. If *COMBIVIR* is discontinued in patients co-infected with Hepatitis B virus, periodic monitoring of both liver function tests and markers of HBV replication should be considered.

- **Patients co-infected with hepatitis C virus**

Exacerbation of anaemia due to ribavirin has been reported when zidovudine is part of the regimen used to treat HIV although the exact mechanism remains to be elucidated. Therefore, the co-administration of ribavirin and zidovudine is not advised and consideration should be given to replacing zidovudine in a combination ART regimen if this is already established. This is particularly important in patients with a known history of zidovudine induced anaemia.

## **Interactions**

As *COMBIVIR* contains lamivudine and zidovudine, any interactions that have been identified with these agents individually may occur with *COMBIVIR*. The interactions listed below should not be considered exhaustive but are representative of the classes of medicinal products where caution should be exercised.

### **Effect of lamivudine on the pharmacokinetics of other agents**

*In vitro*, lamivudine demonstrates no or weak inhibition of the drug transporters organic anion transporter 1B1 (OATP1B1), OATP1B3, breast cancer resistance protein (BCRP) or P-glycoprotein (Pgp), multidrug and toxin extrusion protein 1 (MATE1), MATE2-K or organic cation transporter 3 (OCT3). Lamivudine is therefore not expected to affect the plasma concentrations of drugs that are substrates of these drug transporters.

Lamivudine is an inhibitor of OCT1 and OCT2 *in vitro* with IC<sub>50</sub> values of 17 and 33 µM, respectively, however lamivudine has low potential to affect the plasma concentrations of OCT1 and OCT2 substrates at therapeutic drug exposures (up to 300 mg).

### **Effect of other agents on the pharmacokinetics of lamivudine**

Lamivudine is a substrate of MATE1, MATE2-K and OCT2 *in vitro*. Trimethoprim (an inhibitor of these drug transporters) has been shown to increase lamivudine plasma concentrations, however this interaction is not considered clinically significant as no dose adjustment of lamivudine is needed.

Lamivudine is a substrate of the hepatic uptake transporter OCT1. As hepatic elimination plays a minor role in the clearance of lamivudine, drug interactions due to inhibition of OCT1 are unlikely to be of clinical significance.

Lamivudine is a substrate of Pgp and BCRP, however due to its high bioavailability it is unlikely that these transporters play a significant role in the absorption of lamivudine. Therefore co-administration of drugs that are inhibitors of these efflux transporters is unlikely to affect the disposition and elimination of lamivudine.

### **Interactions relevant to lamivudine:**

The likelihood of metabolic interactions with lamivudine is low due to limited metabolism and plasma protein binding, and almost complete renal elimination of unchanged lamivudine.

Lamivudine is predominantly eliminated by active organic cationic secretion. The possibility of interactions with other medicinal products administered concurrently should be considered, particularly when their main route of elimination is active renal secretion via the organic cationic transport system e.g trimethoprim. Other active substances (e.g. ranitidine, cimetidine) are eliminated only in part by this mechanism and were shown not to interact with lamivudine.

Active substances shown to be predominantly excreted either via the active organic anionic pathway, or by glomerular filtration are unlikely to yield clinically significant interactions with lamivudine.

**Sorbitol:** Coadministration of sorbitol solution (3.2 g, 10.2 g, 13.4 g) with a single 300 mg dose of lamivudine oral solution resulted in dose-dependent decreases of 14%, 32%, and 36% in lamivudine exposure ( $AUC_{\infty}$ ) and 28%, 52%, and 55% in the  $C_{max}$  of lamivudine in adults. When possible, avoid chronic coadministration of sorbitol-containing medicines with COMBIVIR. Consider more frequent monitoring of HIV-1 viral load when chronic coadministration cannot be avoided.

**Trimethoprim:** Administration of trimethoprim/sulphamethoxazole 160 mg/800 mg (co-trimoxazole) causes a 40% increase in lamivudine exposure because of the trimethoprim component. However, unless the patient has renal impairment, no dosage adjustment of lamivudine is necessary. Lamivudine has no effect on the pharmacokinetics of trimethoprim or sulphamethoxazole. The effect of co-administration of lamivudine with higher doses of co-trimoxazole used for the treatment of *Pneumocystis jiroveci* pneumonia and toxoplasmosis has not been studied.

**Emtricitabine:** Lamivudine may inhibit the intracellular phosphorylation of emtricitabine when the two medicinal products are used concurrently. Additionally, the mechanism of viral resistance for both lamivudine and emtricitabine is mediated via mutation of the same viral reverse transcriptase gene (M184V) and therefore the therapeutic efficacy of these drugs in combination therapy may be limited. Lamivudine is not recommended for use in combination with emtricitabine or emtricitabine-containing fixed dose combinations.

### **Interactions relevant to zidovudine:**

Zidovudine is primarily eliminated by hepatic conjugation to an inactive glucuronidated metabolite. Active substances are primarily eliminated by hepatic metabolism especially via glucuronidation may have the potential to inhibit metabolism of zidovudine.

**Atovaquone:** Zidovudine does not appear to affect the pharmacokinetics of atovaquone. However, pharmacokinetic data have shown that atovaquone appears to decrease the rate of metabolism of zidovudine to its glucuronide metabolite (steady state AUC of zidovudine was increased by 33% and peak plasma concentration of the glucuronide was decreased by 19%). At zidovudine dosages of 500 or 600 mg/day it would seem unlikely that a three week, concomitant course of atovaquone for the treatment of acute *Pneumocystis jiroveci* pneumonia would result in an increased incidence of adverse reactions attributable to higher plasma concentrations of zidovudine. Extra care should be taken in monitoring patients receiving prolonged atovaquone therapy.

*Clarithromycin:* Clarithromycin tablets reduce the absorption of zidovudine. This can be avoided by separating the administration of zidovudine and clarithromycin by at least two hours.

*Lamivudine:* Co-administration of zidovudine with lamivudine results in a 13% increase in zidovudine exposure and a 28% increase in peak plasma levels. However overall exposure (AUC) is not significantly altered. Zidovudine has no effect on the pharmacokinetics of lamivudine.

*Phenytoin:* Phenytoin blood levels have been reported to be low in some patients receiving zidovudine, while in one patient a high level was noted. These observations suggest that phenytoin concentrations should be carefully monitored in patients receiving *COMBIVIR* and phenytoin.

*Probenecid:* Limited data suggest that probenecid increases the mean half-life and AUC of zidovudine by decreasing glucuronidation. Renal excretion of the glucuronide (and possibly zidovudine itself) is reduced in the presence of probenecid.

*Rifampicin:* Limited data suggest that co-administration of zidovudine and rifampicin decreases AUC of zidovudine by 48% +/- 34%. However, the clinical significance is not known.

*Stavudine:* Zidovudine may inhibit the intracellular phosphorylation of stavudine when the two medicinal products are used concurrently. Stavudine is therefore not recommended to be used in combination with *COMBIVIR*.

*Miscellaneous:* Other medicinal products, including but not limited to, aspirin, codeine, morphine, methadone, indomethacin, ketoprofen, naproxen, oxazepam, lorazepam, cimetidine, clofibrate, dapsone and isoprinosine, may alter the metabolism of zidovudine by competitively inhibiting glucuronidation or directly inhibiting hepatic microsomal metabolism. Careful thought should be given to the possibilities of interactions before using such medicinal products particularly for chronic therapy, in combination with *COMBIVIR*.

Concomitant treatment, especially acute therapy, with potentially nephrotoxic or myelosuppressive medicinal products (e.g. systemic pentamidine, dapsone, pyrimethamine, co-trimoxazole, amphotericin, flucytosine, ganciclovir, interferon, vincristine, vinblastine and doxorubicin) may also increase the risk of adverse reactions to zidovudine. If concomitant therapy with *COMBIVIR* and any of these medicinal products is necessary then extra care should be taken in monitoring renal function and haematological parameters and, if required, the dosage of one or more agents should be reduced.

Since some patients receiving *COMBIVIR* may continue to experience opportunistic infections, concomitant use of prophylactic antimicrobial therapy may have to be considered. Such prophylaxis has included co-trimoxazole, aerosolised pentamidine, pyrimethamine and acyclovir. Limited data from clinical trials do not indicate a significantly increased risk of adverse reactions to zidovudine with these medicinal products.

## Pregnancy and Lactation

**Fertility:** There are no data on the effect of lamivudine or zidovudine on human female fertility. In men, zidovudine has been shown to have no effect on sperm count, morphology or motility.

**Pregnancy:** Lamivudine and zidovudine have been evaluated in the Antiretroviral Pregnancy Registry (APR) in over 11,000, and 13,000 women respectively during pregnancy and postpartum. Available human data from the APR do not show an increased risk of major birth defects for lamivudine or zidovudine compared to the background rate (*see Clinical Studies*).

The safe use of lamivudine and zidovudine in human pregnancy has not been established in adequate and well-controlled trials investigating congenital abnormalities. Therefore administration of *COMBIVIR* in pregnancy should be considered only if the expected benefit outweighs the possible risk to the foetus.

Lamivudine and zidovudine have been shown to cross the placenta in humans (*see Pharmacokinetics*). The use of zidovudine in pregnant women, with subsequent treatment of the newborn infants, has been shown to reduce the rate of maternal foetal transmission of HIV.

Lamivudine and zidovudine have been associated with findings in animal reproductive studies. Pregnant women considering using *COMBIVIR* during pregnancy should be made aware of these findings.

There have been reports of mild, transient elevations in serum lactate levels, which may be due to mitochondrial dysfunction, in neonates and infants exposed in utero or peri-partum to nucleoside reverse transcriptase inhibitors (NRTIs). The clinical relevance of transient elevations in serum lactate is unknown. There have also been very rare reports of developmental delay, seizures and other neurological disease. However, a causal relationship between these events and NRTI exposure *in utero* or *peri-partum* has not been established. These findings do not affect current recommendations to use antiretroviral therapy in pregnant women to prevent vertical transmission of HIV.

**Lactation:** Health experts recommend where possible HIV-infected women do not breast feed their infants in order to avoid transmission of HIV. Both lamivudine and zidovudine are excreted in human milk at similar concentrations to those found in serum. Since lamivudine, zidovudine and HIV virus pass into breast milk it is recommended that mothers taking *COMBIVIR* do not breast feed their infants.

## Effects on Ability to Drive and Use Machines

There have been no studies to investigate the effect of lamivudine or zidovudine on driving performance or the ability to operate machinery. Further, a detrimental effect on such activities cannot be predicted from the pharmacology of the active substances. Nevertheless, the clinical status of the patient and the adverse event profile of lamivudine and zidovudine should be borne in mind when considering the patient's ability to drive or operate machinery.

## Adverse Reactions

Adverse events have been reported during therapy for HIV disease with lamivudine and zidovudine separately or in combination. With many it is unclear whether they are related to lamivudine, zidovudine, or to the wide range of medicinal products used in the management of HIV disease or are as a result of the underlying disease process. As *COMBIVIR* contains lamivudine and zidovudine the type and severity of adverse reactions associated with each of the compounds, which are listed below may be expected. There is no evidence of added toxicity following concurrent administration of the two compounds.

The following convention has been utilised for the classification of undesirable effects: Very common (>1/10), common (>1/100, <1/10), uncommon (>1/1,000, <1/100), rare (>1/10,000, <1/1,000) very rare (<1/10,000).

### Lamivudine:

#### *Blood and lymphatic systems disorders*

Uncommon: Neutropenia, anaemia, thrombocytopenia

Very rare: Pure red cell aplasia

#### *Metabolism and nutrition disorders*

Common: Hyperlactataemia.

Rare: Lactic acidosis (*see Warnings and Precautions*).

#### *Nervous system disorders*

Common: Headache

Very rare: Paraesthesia. Peripheral neuropathy has been reported although a causal relationship to treatment is uncertain

#### *Gastrointestinal disorders*

Common: Nausea, vomiting, upper abdominal pain, diarrhoea

Rare: Pancreatitis, although a causal relationship to treatment is uncertain. Rises in serum amylase.

#### *Hepatobiliary disorders*

Uncommon: Transient rises in liver enzymes (AST, ALT)

#### *Skin and subcutaneous tissue disorders*

Common: Rash, alopecia

### ***Musculoskeletal and connective tissue disorders***

Common: Arthralgia, muscle disorders

Rare: Rhabdomyolysis

### ***General disorders and administration site conditions***

*Common:* Fatigue, malaise, fever

### **Zidovudine:**

### ***Blood and lymphatic system disorders***

*Common:* Anaemia (which may require transfusions), neutropenia and leucopenia

These occur more frequently at higher dosages (1200-1500mg/day) and in patients with advanced HIV disease (especially when there is poor bone marrow reserve prior to treatment), and particularly in patients with CD4 cell counts less than 100/mm<sup>3</sup>. Dosage reduction or cessation of therapy may become necessary (*see Warnings and Precautions*). The incidence of neutropenia was also increased in those patients whose neutrophil counts, haemoglobin levels and serum vitamin B<sub>12</sub> levels were low at the start of zidovudine therapy.

Uncommon: Thrombocytopenia and pancytopenia (with marrow hypoplasia)

Rare: Pure red cell aplasia

Very rare: Aplastic anaemia

### ***Metabolism and nutrition disorders***

Common: Hyperlactataemia.

Rare: Lactic acidosis (*see Warnings and Precautions*), anorexia.

Treatment with zidovudine has been associated with loss of subcutaneous fat (*see Warnings and Precautions*).

### ***Psychiatric disorders***

Rare: Anxiety and depression

### ***Nervous system disorders***

Very common: Headache

Common: Dizziness

Rare: Insomnia, paraesthesia, somnolence, loss of mental acuity, convulsions.

### ***Cardiac disorders***

Rare: Cardiomyopathy

### ***Respiratory, thoracic and mediastinal disorders***

Uncommon: Dyspnoea

Rare: Cough

### ***Gastrointestinal disorders***

Very common: Nausea

Common: Vomiting, abdominal pain, and diarrhoea

Uncommon: Flatulence

Rare: Oral mucosa pigmentation, taste disturbance and dyspepsia. Pancreatitis.

### ***Hepatobiliary disorders***

Common: Raised blood levels of liver enzymes and bilirubin

Rare: Liver disorders such as severe hepatomegaly with steatosis

### ***Skin and subcutaneous tissue disorders***

Uncommon: Rash and pruritus

Rare: Nail and skin pigmentation, urticaria and sweating

### ***Musculoskeletal and connective tissue disorders***

Common: Myalgia

Uncommon: Myopathy

### ***Renal and urinary disorders***

Rare: Urinary frequency

### ***Reproductive system and breast disorders***

Rare: Gynaecomastia

### ***General disorders and administration site conditions***

Common: Malaise

Uncommon: Fever, generalised pain and asthenia

Rare: Chills, chest pain and influenza-like syndrome

## Overdose

There is limited experience of overdosage with *COMBIVIR*. No specific symptoms or signs have been identified following acute overdose with zidovudine or lamivudine apart from those listed as undesirable effects. No fatalities occurred, and all patients recovered.

If overdosage occurs the patient should be monitored for evidence of toxicity (*see Adverse Reactions*), and standard supportive treatment applied as necessary. Since lamivudine is dialysable, continuous haemodialysis could be used in the treatment of overdosage, although this has not been studied. Haemodialysis and peritoneal dialysis appear to have a limited effect on elimination of zidovudine, but enhance the elimination of the glucuronide metabolite. For more details physicians should refer to the individual prescribing information for lamivudine and zidovudine.

## PHARMACOLOGICAL PROPERTIES

### Pharmacodynamics

Pharmacotherapeutic group - nucleoside analogue, ATC Code: J05 A F30.

#### ***Mechanism of Action***

Lamivudine and zidovudine are potent, selective inhibitors of HIV-1 and HIV-2. Both drugs are metabolised sequentially by intracellular kinases to the 5'-triphosphate (TP). Lamivudine-TP and zidovudine-TP are substrates for and competitive inhibitors of HIV reverse transcriptase. However, their main antiviral activity is through incorporation of the monophosphate form into the viral DNA chain, resulting in chain termination. Lamivudine and zidovudine triphosphates show significantly less affinity for host cell DNA polymerases. No antagonistic effects *in vitro* were seen with lamivudine and other antiretrovirals (tested agents: abacavir, didanosine, nevirapine, zalcitabine, and zidovudine). No antagonistic effects *in vitro* were seen with zidovudine and other antiretrovirals (tested agents: abacavir, didanosine, lamivudine and interferon-alpha).

*In vitro*, lamivudine demonstrates low cytotoxicity to peripheral blood lymphocytes, to established lymphocyte and monocyte-macrophage cell lines, and to a variety of bone marrow progenitor cells *in vitro*. Lamivudine therefore has, *in vitro*, a high therapeutic index.

#### ***Pharmacodynamic Effects***

HIV-1 resistance to lamivudine involves the development of a M184V amino acid change close to the active site of the viral reverse transcriptase (RT). This variant arises both *in vitro* and in HIV-1 infected patients treated with lamivudine-containing antiretroviral therapy. M184V mutants display greatly reduced susceptibility to lamivudine and show diminished viral replicative capacity *in vitro*. *In vitro* studies indicate that zidovudine-resistant virus isolates can become zidovudine sensitive when

they simultaneously acquire resistance to lamivudine. The clinical relevance of such findings remains, however, not well defined.

Cross-resistance conferred by the M184V RT is limited within the nucleoside inhibitor class of antiretroviral agents. Zidovudine and stavudine maintain their antiretroviral activities against lamivudine-resistant HIV-1. Abacavir maintains its antiretroviral activities against lamivudine-resistant HIV-1 harbouring only the M184V mutation. The M184V RT mutant shows a <4-fold decrease in susceptibility to didanosine and zalcitabine; the clinical significance of these findings is unknown.

Resistance to thymidine analogues (of which zidovudine is one) is well characterised and is conferred by the stepwise accumulation of up to six specific mutations in the HIV reverse transcriptase at codons 41, 67, 70, 210, 215 and 219. Viruses acquire phenotypic resistance to thymidine analogues through the combination of mutations at codons 41 and 215 or by the accumulation of at least four of the six mutations. These thymidine analogue mutations alone do not cause high-level cross-resistance to any of the other nucleosides, allowing for the subsequent use of any of the other approved reverse transcriptase inhibitors.

Two patterns of multi-drug resistance mutations, the first characterised by mutations in the HIV reverse transcriptase at codons 62, 75, 77, 116 and 151 and the second typically involving a T69S mutation plus a 6-base pair insert at the same position, result in phenotypic resistance to AZT as well as to the other approved nucleoside reverse transcriptase inhibitors. Either of these two patterns of multinucleoside resistance mutations severely limits future therapeutic options.

In clinical studies, lamivudine in combination with zidovudine has been shown to reduce HIV-1 viral load and to increase CD4 cell counts. Clinical end-point data indicate that lamivudine in combination with zidovudine alone or in combination with zidovudine containing treatment regimens results in a significant reduction in the risk of disease progression and mortality.

Individually, lamivudine and zidovudine therapy has resulted in HIV clinical isolates which show reduced sensitivity *in vitro* to the nucleoside analogue to which they have been exposed. Evidence from clinical studies show that lamivudine plus zidovudine delays the emergence of zidovudine-resistant isolates in individuals with no prior antiretroviral therapy.

*In vitro* susceptibility testing has not been standardised and results may vary according to methodological factors. The relationship between *in vitro* susceptibility of HIV to lamivudine and/or zidovudine and the clinical response to therapy remain under investigation.

Lamivudine and zidovudine have been widely used as components of antiretroviral combination therapy with other antiretroviral agents of the same class (nucleoside reverse transcriptase inhibitors) or different classes (protease inhibitors, non-nucleoside reverse transcriptase inhibitors).

Multiple drug antiretroviral therapy containing lamivudine has been shown to be effective in antiretrovirally-naive patients as well as in patients presenting with viruses containing the M184V mutations.

#### *Post-exposure prophylaxis (PEP):*

Internationally recognised guidelines (Centre for Disease Control and Prevention - June 1998), recommend that in the event of accidental exposure to HIV-infected blood e.g. from a needlestick injury, a combination of zidovudine and lamivudine should be administered promptly (within one to two hours). In cases of higher risk of infection a protease inhibitor should be included in the regimen. It is recommended that antiretroviral prophylaxis be continued for four weeks. No controlled clinical studies have been carried out in post-exposure prophylaxis and supporting data is limited. Seroconversion may still occur despite prompt treatment with antiretroviral agents.

## **Pharmacokinetics**

### ***Absorption***

Lamivudine and zidovudine are well absorbed from the gut. The bioavailability of oral lamivudine in adults is normally between 80-85% and for zidovudine 60-70%.

A bioequivalence study compared *COMBIVIR* with *EPIVIR*<sup>TM</sup> 150mg and *RETROVIR*<sup>TM</sup> 300mg tablets taken together. The effect of food on the rate and extent of absorption was also studied. *COMBIVIR* was shown to be bioequivalent to *EPIVIR* 150mg and *RETROVIR* 300mg given as separate tablets, when administered to fasting subjects.

Following *COMBIVIR* administration, lamivudine and zidovudine  $C_{max}$  (95% confidence interval) values were 1.5 (1.3-1.8) µg/ml and 1.8 (1.5-2.2) µg/ml respectively. The median (range) lamivudine and zidovudine  $t_{max}$  values were 0.75 (0.50-2.00) hours and 0.50 (0.25-2.00) hours respectively. The extent (AUC) of lamivudine and zidovudine absorption and estimates of half-life following administration of *COMBIVIR* with food were similar when compared to fasting subjects, although the rate of absorption ( $C_{max}, t_{max}$ ) was slowed. Based on these data *COMBIVIR* may be administered with or without food.

### ***Distribution***

Intravenous studies with lamivudine and zidovudine showed that the mean apparent volume of distribution is 1.3 and 1.6 l/kg respectively. Lamivudine exhibits linear pharmacokinetics over the therapeutic dose range and displays limited binding to the major plasma protein albumin (less than 36% serum albumin *in vitro*). Zidovudine plasma protein binding is 34% to 38%. Interactions with medicinal products involving binding site displacement are not anticipated with *COMBIVIR*.

Data show that lamivudine and zidovudine penetrate the central nervous system and reach the cerebrospinal fluid (CSF). The mean ratios of CSF/serum lamivudine and zidovudine concentrations 2-4 hours after oral administration were approximately 0.12

and 0.5 respectively. The true extent of penetration of lamivudine or relationship with any clinical efficacy is unknown.

### ***Metabolism***

Metabolism of lamivudine is a minor route of elimination. Lamivudine is predominately cleared by renal excretion of the unchanged active substance. The likelihood of metabolic interactions with lamivudine is low due to the small extent of hepatic metabolism (5-10%) and low plasma binding.

The 5'-glucuronide of zidovudine is the major metabolite in both plasma and urine, accounting for approximately 50-80% of the administered dose eliminated by renal excretion. 3'-amino-3'-deoxythymidine (AMT) has been identified as a metabolite of zidovudine following intravenous dosing.

### **Elimination**

The observed lamivudine half-life of elimination is 5 to 7 hours. The mean systemic clearance of lamivudine is approximately 0.32 l/h/kg, with predominantly renal clearance (greater than 70%) via the organic cationic transport system.

From studies with intravenous zidovudine, the mean terminal plasma half-life was 1.1 hours and the mean systemic clearance was 1.6 l/h/kg. Renal clearance of zidovudine is estimated to be 0.34 l/h/kg, indicating glomerular filtration and active tubular secretion by the kidneys.

### ***Special Patient Populations***

- **Elderly**

The pharmacokinetics of lamivudine and zidovudine have not been studied in patients over 65 years of age.

- **Renal Impairment**

Studies in patients with renal impairment show lamivudine elimination is affected by renal dysfunction, due to decreased renal clearance. Dose reduction is required for patients with creatinine clearance of less than 50 ml/min. Zidovudine concentrations have also been shown to be increased in patients with advanced renal failure.

- **Hepatic Impairment**

Limited data in patients with cirrhosis suggest that accumulation of zidovudine may occur in patients with hepatic impairment because of decreased glucuronidation. Dosage adjustment of zidovudine may be necessary in patients with severe hepatic impairment.

- **Pregnancy**

The pharmacokinetics of lamivudine and zidovudine in pregnant adults were similar to that of non-pregnant adults. In humans, consistent with passive transmission of lamivudine across the placenta, lamivudine concentrations in infant serum at birth were

similar to those in maternal and cord serum at delivery. Zidovudine was measured in plasma and gave similar results to those observed for lamivudine.

## **Clinical Studies**

The Antiretroviral Pregnancy Registry (APR) has received reports of over 11,000 exposures to lamivudine during pregnancy resulting in live birth. These consist of over 4,500 exposures during the first trimester, over 7,200 exposures during the second/third trimester and included 143 and 207 birth defects respectively. The prevalence (95% CI) of defects in the first trimester was 3.1% (2.6, 3.7%) and in the second/third trimester, 2.9% (2.5, 3.3%). The APR has received reports of over 13,000 exposures to zidovudine during pregnancy resulting in live birth. These consist of over 4,100 exposures during the first trimester, over 9,300 exposures during the second/third trimester and included 133 and 264 birth defects respectively. The prevalence (95% CI) of defects in the first trimester was 3.2% (2.7, 3.8%) and in the second/third trimester, 2.8% (2.5, 3.2%). These proportions are not significantly higher than those reported in the two population based surveillance systems (2.72 per 100 live births and 4.17 per 100 live births respectively). The Antiretroviral Pregnancy Registry does not show an increased risk of major birth defects for lamivudine or zidovudine compared to the background rate.

## **Shelf Life**

The expiry date is indicated on the packaging.

## **Special Precautions for Storage**

Store below 30°C.

## **Product Registrant**

GlaxoSmithKline Pte. Ltd.

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