PRODUCT MONOGRAPH

îü BUDESONIDE

Budesonide Controlled Ileal Release Capsules 3 mg

Glucocorticosteroid for the Treatment of
Crohn’s Disease Affecting the Ileum and/or Ascending Colon

Tillotts Pharma GmbH
Warmbacher Strasse 80
79618 Rheinfelden
Germany

Importer/Distributor:
C.R.I.
4 Innovation Drive
Dundas, Ontario
L9H 7P3

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PRODUCT MONOGRAPH

NAME OF DRUG

BUDESONIDE

Budesonide Controlled Ileal Release Capsules 3 mg

THERAPEUTIC CLASSIFICATION

Glucocorticosteroid for the Treatment of Crohn’s Disease Affecting the Ileum and/or Ascending Colon

ACTIONS AND CLINICAL PHARMACOLOGY

The active ingredient of BUDESONIDE capsules, budesonide, is a potent non-halogenated synthetic glucocorticosteroid with high topical potency and weak systemic effects.

The exact mechanism of action of glucocorticosteroids in the treatment of Crohn’s disease is not fully understood. Anti-inflammatory actions, such as the inhibition of inflammatory mediator release and inhibition of immunological cellular responses, are probably important.

Data from clinical pharmacology studies and controlled clinical trials indicate that BUDESONIDE capsules, at least partly, act topically. Budesonide undergoes an extensive degree (approximately 90%) of biotransformation in the liver to metabolites with low glucocorticosteroid activity. The glucocorticosteroid activity of the major metabolites, 6β-hydroxybudesonide and 16α-hydroxyprednisolone, is less than 1% of that of budesonide. The metabolism of budesonide is primarily mediated by CYP 3A4, an isozyme of cytochrome P450.

The favourable separation between topical anti-inflammatory and systemic effect is due to strong glucocorticosteroid receptor affinity and an effective first pass metabolism by the liver with a short half-life. A glucocorticosteroid with such a profile is of particular importance for the local treatment of inflammatory bowel diseases such as Crohn’s disease. With regard to treatment of this disease with glucocorticosteroids, it is essential to achieve a high local anti-inflammatory activity in the bowel wall with systemic side-effects, e.g. on the hypothalamic pituitary adrenal (HPA) axis function, as low as possible.
INDICATIONS AND CLINICAL USE
BUDESONIDE capsules are indicated for:

- the treatment of mild to moderate active Crohn's disease involving the ileum and/or the ascending colon and
- the maintenance of clinical remission of mild to moderate Crohn’s disease involving the ileum and/or the ascending colon for up to 3 months.

CONTRAINDICATIONS
BUDESONIDE capsules are contraindicated for the following:

- Systemic or local bacterial, fungal or viral infections.
- Known hypersensitivity to any of the ingredients.
- Active tuberculosis.

WARNINGS
Glucocorticosteroids can reduce the response of the HPA-axis to stress. In situations where patients are subject to surgery or other stress situations, supplementation with a conventional glucocorticosteroid is recommended.

Special care is demanded in treatment of patients transferred from conventional systemic steroids to BUDESONIDE capsules as disturbances in the HPA-axis could be expected in these patients.

PRECAUTIONS
Glucocorticosteroids may mask some signs of infections and new infections may appear. A decreased resistance to localized infection has been observed during glucocorticosteroid therapy. Viral infections such as chicken pox and measles can have a more serious or fatal course in patients on immunosuppressant glucocorticosteroids. In adults who have not had these diseases, particular care should be taken to avoid exposure. If exposed to chicken pox or measles, therapy with varicella zoster immune globulin (VZIG) or pooled intravenous immunoglobulin (IVIG), as appropriate, may be indicated. If chicken pox develops, treatment with antiviral agents may be considered.

Although treatment with BUDESONIDE capsules causes significantly less lowering of plasma cortisol compared to conventional glucocorticosteroids, the knowledge with regard to treatment during the following conditions is limited and therefore cautioned: active peptic ulcer, osteoporosis, acute glomerulonephritis, myasthenia gravis, exanthematous diseases, diverticulitis, thrombophlebitis, psychic disturbances, diabetes (or family history of diabetes), cataracts and glaucoma (or family history of glaucoma) which may cause elevation of intraocular pressure, hypertension, hyperthyroidism, acute coronary disease, limited cardiac
reserve and pregnancy. In such cases the benefits of an oral glucocorticosteroid must be weighed against the risks.

With the recommended therapeutic doses of budesonide, the risk/benefit ratio seems to be low for the long-term systemic effects. However, as with any other glucocorticosteroid, patients should be carefully followed up for systemic adverse effects. During long-term therapy, adrenal function and haematological status should be periodically assessed.

Visual disturbance may be reported with systemic and topical corticosteroid use. If a patient presents with symptoms such as blurred vision or other visual disturbances, the patient should be considered for referral to an ophthalmologist for evaluation of possible causes which may include cataract, glaucoma or rare diseases such as central serous chorioretinopathy (CSCR) which have been reported after use of systemic and topical corticosteroids.

Particular care is needed in patients who are transferred from systemic glucocorticosteroid treatment with higher systemic effect to BUDESONIDE capsules. When BUDESONIDE is used to replace prednisolone in steroid dependent patients, the daily dose should not exceed 6 mg. When treatment with BUDESONIDE capsules is initiated, the prednisolone dose should be tapered, as these patients may experience adrenal cortical suppression. Therefore, monitoring of adrenocortical function may be considered in these patients. Some patients feel unwell in a non-specific way during the withdrawal phase, e.g., pain in muscles and joints. Sometimes, this can also unmask allergies e.g. rhinitis and eczema, which were previously controlled by the systemic drug. A general insufficient glucocorticosteroid effect should be suspected if, in rare cases, symptoms such as tiredness, headache, nausea and vomiting should occur. In these cases a temporary increase in the dose of systemic glucocorticosteroids is sometimes necessary.

Patients should be advised to inform subsequent physicians of the prior use of glucocorticosteroids.

Glucocorticosteroids should be used with caution in patients if there is a probability of bowel perforation as well as the probability of obstruction, abscess or other pyogenic infection and fresh intestinal anastomoses. Aggravation of diabetes mellitus or stimulation of manifestations of latent diabetes mellitus may be caused by glucocorticosteroid therapy.

There may be an enhanced systemic effect of budesonide in patients with liver cirrhosis since the metabolism of budesonide may be impaired and, as with other glucocorticosteroids, there may be enhanced effects in those with hypothyroidism. Reduced liver function may affect the elimination of corticosteroids. The intravenous pharmacokinetics of budesonide are, however, similar in cirrhotic patients and in healthy subjects. The pharmacokinetics after oral ingestion of budesonide were affected by compromised liver function as evidenced by increased systemic availability.

In vivo studies in male subjects, have shown that oral administration of ketoconazole (a known inhibitor of CYP3A activity in the liver and in the intestinal mucosa, see Drug Interactions - Ketoconazole) caused a four to seven fold increase of the systemic exposure to oral
budesonide. If treatment with CYP3A inhibitors, including ketoconazole and cobicistat-containing products (and possibly other azoles such as fluconazole, itraconazole or miconazole) together with budesonide is indicated, reduction of the budesonide dose should be considered if side effects typical of systemic glucocorticosteroids occur. If this is not possible, the period between treatments should be as long as possible. See Drug Interactions.

After extensive intake of grapefruit juice (observed in male subjects taking in 600 mL of concentrated grapefruit juice per day for 4 days), the systemic exposure for oral budesonide increased approximately 2-fold. Grapefruit juice inhibits CYP3A activity predominantly in the intestinal mucosa. As with other drugs primarily being metabolized through CYP3A, regular ingestion of grapefruit or its juice, should be avoided in connection with budesonide administration (other juices such as orange juice or apple juice do not inhibit CYP3A). See Drug Interactions - Grapefruit Juice.

Glucocorticosteroid therapy may cause hyperacidity of peptic ulcer.

Acetylsalicylic acid should be used cautiously in conjunction with glucocorticosteroids in hypoprothrombinemia.

Because adrenal function may be suppressed, an ACTH stimulation test for diagnosing pituitary insufficiency might show false results (low values).

**Usage During Pregnancy**

Administration of BUDESONIDE capsules during pregnancy should be avoided unless there are compelling reasons. In experimental animal studies, budesonide was found to cross the placental barrier. Like other glucocorticosteroids, budesonide is teratogenic to rodent species. High doses of budesonide administered subcutaneously produced fetal malformations, primarily skeletal defects, in rabbits, rats, and in mice. The relevance of these findings to humans has not yet been established. In the absence of further studies in humans, budesonide should be used during pregnancy only if the potential benefits clearly outweigh the risk to the fetus. Infants born of mothers who have received substantial doses of glucocorticosteroids during pregnancy should be carefully observed for hypoadrenalism.

**Lactation**

Budesonide is excreted in breast milk. However, based on data from inhaled budesonide, at therapeutic doses of BUDESONIDE, exposure to the infant is anticipated to be low. The use of BUDESONIDE capsules in nursing mothers requires that the possible benefits of the drug be weighed against the potential hazards to the mother, or infant.

**Children**

The safety and effectiveness of BUDESONIDE capsules in children have not been established, therefore use in this age group is not recommended.
Drug Interactions

To date, budesonide has not been observed to interact with other drugs used for the treatment of inflammatory bowel diseases.

Elevated plasma levels and enhanced effects of corticosteroids have been reported in women also receiving estrogens or oral contraceptives. However, a low-dose combination (ethinylestradiol/desogestrel: 30 µg/150 µg) oral contraceptive that more than doubled the plasma concentration of oral prednisolone, had no significant effect on the plasma concentration of oral budesonide.

The metabolism of budesonide is primarily mediated by CYP3A4, an isozyme of cytochrome P450. Inhibition of this enzyme by e.g. ketoconazole and cobicistat-containing products (and possibly other azoles such as fluconazole, itraconazole or miconazole), cyclosporin, troleandomycin, erythromycin or grapefruit juice can therefore increase the systemic exposure to budesonide.

Cimetidine

The kinetics of budesonide were investigated in healthy subjects without and with cimetidine, 1000 mg daily. After a 4 mg oral dose the values of $C_{\text{max}}$ (nmol/L) and systemic availability (%) of budesonide without and with cimetidine (3.3 vs 5.1 nmol/L and 10 vs 12%, respectively) indicated a slight inhibitory effect on hepatic metabolism of budesonide, caused by cimetidine. This should be of little clinical importance.

Ketoconazole

Ketoconazole, a potent inhibitor of cytochrome P 450 3A, the main metabolic enzyme for corticosteroids, increases plasma levels of orally ingested budesonide.

Omeprazole

At recommended doses, omeprazole has no effect on the pharmacokinetics of oral budesonide.

ADVERSE REACTIONS

In clinical trials, most adverse events experienced by patients or healthy volunteers receiving BUDESONIDE capsules were of mild to moderate intensity and were classified as non-serious. A total of 577 patients with Crohn's disease were treated with BUDESONIDE capsules for induction and maintenance of remission, in controlled clinical trials.

Adverse events reported in patients during induction of remission (n=399) with BUDESONIDE capsules included dyspepsia (9%), depression (1%), muscle cramps (4%), palpitations (2%), blurred vision (3%), skin reactions including rash and urticaria (6%), and menstrual disorders (2%).

A similar adverse event profile was reported in patients during 3 long term (up to 12 months) maintenance treatment studies (n=178) with BUDESONIDE capsules. The nature and
incidence of adverse events was generally the same or less than observed during treatment for induction of remission.

Other side effects that have been reported include hypokalemia, tremor, psychomotor hyperactivity, ecchymosis, cataract including subcapsular cataract and behavioural changes such as nervousness, insomnia, anxiety, aggression and mood swings.

Most of the adverse events mentioned in this product monograph can also be expected for other treatments with glucocorticoids.

Side effects typical of systemic glucocorticosteroids (such as Cushingoid features and reduced growth velocity) may occur. The systemic effects of budesonide on the HPA-axis were found to be dose-dependent. Effects can also be dependent on treatment time, concomitant and previous glucocorticosteroid intake and individual sensitivity.

In very rare cases, anaphylactic reactions have been reported during post marketing use.

**SYMPTOMS AND TREATMENT OF OVERDOSAGE**

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

Reports of acute toxicity and/or death following overdosage with glucocorticosteroids are rare. Thus, acute overdosage with BUDESONIDE capsules, even in excessive doses, is not expected to be a clinical problem. In the event of acute overdosage, no specific antidote is available. Treatment consists of immediate gastric lavage or emesis followed by supportive and symptomatic therapy.

Occasional overdosing will not give any obvious symptoms in most cases but it will decrease the plasma cortisol level and increase the number and percentage of circulating neutrophils. The number and percentage of eosinophils will decrease concurrently. Stopping the treatment or decreasing the dose will abolish the induced effects.

Habitual overdosing may cause hypercorticism and HPA-suppression. Decreasing the dose or stopping the therapy, with the accepted procedures for discontinuing prolonged oral therapy with systemic steroids, will abolish these effects, although the restituation of the HPA-axis may be a slow process and during periods with pronounced physical stress (severe infections, trauma, surgical operations, etc.) it may be advisable to supplement with conventional systemic steroids.
DOSAGE AND ADMINISTRATION

Active Disease

The recommended daily dose for induction of remission is 9 mg, administered once daily in the morning, for up to 8 weeks. The dose should be taken before meals. Full effect is usually achieved within 2 - 4 weeks.

Maintenance of Remission

Following an 8 week course of treatment for the active disease and once the patient’s symptoms are controlled (CDAI <150), BUDESONIDE 6 mg is recommended, administered daily in the morning before breakfast, for maintenance of clinical remission up to 3 months. If symptom control is still maintained at 3 months, an attempt to taper to complete cessation is recommended. The rate of tapering should be patient-specific and the patient should be monitored by the treating physician during this period. Continued treatment with BUDESONIDE 6 mg for more than 3 months has not been shown to provide substantial clinical benefit.

The capsules should be swallowed whole with water, and not chewed, broken or crushed before being swallowed.

PHARMACEUTICAL INFORMATION

Drug Substance

Chemical Structure:

Generic Name: Budesonide

Chemical Name: Budesonide is a mixture of two isomers:
1. Pregna-1,4-diene-3,20-dione, 16,17-butyldenbergis(oxy)-11,21-dihydroxy-,\([11\beta,16\alpha (R)]\)

and

2. Pregna-1,4-diene-3,20-dione, 16,17-butyldenbergis(oxy)-11,21-dihydroxy-,\([11\beta,16\alpha (S)]\).

Molecular Formula: \(C_{25}H_{34}O_6\)

Molecular Weight: 430.5
**Drug Substance**

**Description:** Budesonide is a non-halogenated glucocorticosteroid and consists of a 1:1 mixture of two epimers, 22R and 22S. It is a white to off-white crystalline powder and is freely soluble in chloroform, sparingly soluble in ethanol, practically insoluble in water and in heptane. Budesonide melts at 224°C to 231.5°C, with decomposition.

**Composition**

<table>
<thead>
<tr>
<th>Active:</th>
<th>budesonide, micronized</th>
<th>3 mg/capsule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-medicinal:</td>
<td>Acetyltributyl citrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dimethicone (Antifoam M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylcellulose</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gelatin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iron oxide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methacrylic acid copolymer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polysorbate 80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium lauryl sulphate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sugar Spheres (sucrose and maize starch)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Talc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Titanium dioxide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triethylcitrate</td>
<td></td>
</tr>
</tbody>
</table>

**Stability and Storage Recommendations**

The capsules are provided in a high density polyethylene bottle, with a polypropylene screw cap containing a desiccant. The capsules should be dispensed and stored in the original container.

The patient should be advised to keep the bottle tightly capped.

Store at controlled room temperature (15-30°C).

**AVAILABILITY OF DOSAGE FORMS**

BUDESONIDE 3 mg capsules are two-piece hard gelatin capsules with an opaque light grey body and an opaque pink cap. The cap has 3 mg in black radial print.

The capsules are provided in a high density polyethylene bottle of 100's.
CLINICAL TRIALS

Treatment of Active Disease

The safety and efficacy of BUDESONIDE capsules were evaluated in 611 patients (n=399 treated with BUDESONIDE, n=66 given placebo and n=146 treated with prednisolone) with mild to moderate active Crohn’s disease of the ileum and/or ascending colon in 3 randomized, double-blind multicentre studies with a parallel group design. The study patients ranged in age from 17 to 85 (mean 36) years, 39% were male and 99.5% were Caucasian. The Crohn’s Disease Activity Index (CDAI) was the main clinical assessment used for determining efficacy in these studies. The CDAI is a validated index based on subjective aspects rated by the patient (frequency of liquid or very soft stools, abdominal pain rating and general well-being) and objective observations (number of extraintestinal symptoms, need for antidiarrheal drugs, presence of abdominal mass, body weight and hematocrit). Clinical improvement, defined as a CDAI score of \( \leq 150 \) assessed after 8 weeks of treatment, was the primary efficacy variable in these comparative efficacy studies of BUDESONIDE capsules (P values below 5% were considered significant). Safety assessments in these studies included monitoring of adverse experiences. A checklist of potential symptoms of hypercorticism was used.

Study One (Table 1) involved 258 patients and tested the safety and efficacy of graded doses of BUDESONIDE capsules (1.5 mg b.i.d., 4.5 mg b.i.d. or 7.5 b.i.d.) versus placebo. The 3 mg per day dose level (data not shown in Table 1) could not be differentiated from placebo (P = 0.13). The remission rates (CDAI \( \leq 150 \)) in the 9 mg arm were found to be significantly higher than those in the placebo group subsequent to the completion of an 8 week treatment period (51% versus 20%, P = 0.0004). There was no additional benefit seen when the daily BUDESONIDE dose was increased from 9 mg to 15 mg per day (P = 0.34, data not shown in Table 1). The median CDAI score after Week 8 of treatment decreased in the 9 mg arm by 121 points relative to baseline (median CDAI score at baseline was 290) in comparison to a decrease of 21 points in the placebo group.

Studies 2 and 3 (Table 1) compared BUDESONIDE capsules (4.5 mg b.i.d. and/or 9 mg o.m.) with oral prednisolone (initial dose of 40 mg, given once daily). At baseline, the median CDAI score was 277 in both studies. Results presented for Study 2 and Study 3 correspond to data collected subsequent to an 8 week treatment period. In Study 2, 13% fewer patients in the BUDESONIDE 9 mg o.m. group experienced clinical improvement than in the prednisolone group (no statistical difference, P = 0.12). Equal clinical improvement rates (60%) were seen in the BUDESONIDE 9 mg o.m. and the prednisolone groups in Study 3 (no statistical difference, P = 0.062). The decrease in median CDAI score seen in Study 3 between the BUDESONIDE 9 mg o.m. and prednisolone groups was 141 and 149 points, respectively.

The proportion of patients with normal plasma cortisol values (\( \geq 150 \) nmol/L) was significantly higher in the BUDESONIDE groups in both Studies 2 and 3 (59% - 66%) than in the prednisolone groups (24%).
Table 1. Clinical Improvement Rates (CDAI ≤150) After 8 weeks of Treatment

<table>
<thead>
<tr>
<th>Clinical Study</th>
<th>BUDESONIDE 9 mg (o.m.)</th>
<th>BUDESONIDE 4.5 mg (b.i.d.)</th>
<th>Placebo</th>
<th>Prednisolone (o.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31/61 (51%)</td>
<td>13/64 (20%)</td>
<td></td>
<td>56/85 (65%)</td>
</tr>
<tr>
<td>2</td>
<td>45/86 (52%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>35/58 (60%)</td>
<td>25/60 (42%)</td>
<td></td>
<td>35/58 (60%)</td>
</tr>
</tbody>
</table>

Note: o.m. - dose administered once daily in morning, b.i.d. - dose administered twice daily.

Maintenance of Clinical Remission

The efficacy and safety of BUDESONIDE capsules for maintenance of clinical remission were evaluated in 3 double-blind, placebo-controlled, multicentre 12-month trials in which 270 patients were randomized and treated once daily with 3 mg or 6 mg BUDESONIDE or placebo (n=178 treated with BUDESONIDE). Patients ranged in age from 18 to 71 (mean 36) years. Forty one percent of the patients were male and 99.6% were Caucasian. The mean CDAI at entry was 98. In 2 of the 3 clinical studies conducted, 80% (156/195) of the patients enrolled had exclusively ileal disease (disease location was not recorded in the third study). Colonoscopy was not performed following treatment. BUDESONIDE 6 mg/day prolonged the time to relapse, defined as an increase in CDAI of at least 60 units to a total score >150 or withdrawal due to disease deterioration. The median time to relapse in the pooled population of the 3 studies was 154 days for patients taking placebo and 263 days for patients taking BUDESONIDE 6 mg/day (P = 0.011). BUDESONIDE 6 mg/day reduced the proportion of patients with loss of symptom control relative to placebo in the pooled population for the 3 studies at 3 months (26% vs. 45% for placebo).

PHARMACOLOGY

Animal Pharmacology

Budesonide exhibits typical glucocorticoid effects in that subcutaneous administration to adrenalectomized rats induced glycogen deposition in the liver, increased urinary volume and only slightly affected sodium excretion.

Whole body autoradiography in mice has shown budesonide and its metabolites to have a similar distribution pattern to other glucocorticosteroids with a high distribution to endocrine organs.

Data from preclinical investigations show a rapid elimination of the drug in all investigated species (rat, mouse, rabbit and dog). This rapid systemic elimination is attributed to extensive liver metabolism, mainly via oxidative and reductive pathways. No or insignificant metabolism of budesonide was found in target organs such as lung and skin. This is as a result
of low amounts of the enzyme system (cytochrome P450 3A) which is responsible for the metabolism of budesonide in these organs.

**Human Pharmacology**

**Pharmacodynamics**

**Mode of Action**

The pathogenesis of Inflammatory Bowel Disease in general, and of Crohn’s Disease (CD) in particular is not known. However, inflammatory immune responses are probably prominent features. Glucocorticosteroid drugs have the potential to interact with many aspects of this response, as they have a wide range of inhibitory activities against multiple cell types and mediators. Of importance in CD is probably the blocking of inflammatory cell influx, the inhibition of inflammatory mediator release by blockage of the arachidonic acid pathway, and the blocking of cytokine-mediated immune events. The intrinsic potency of budesonide, measured as the affinity to the glucocorticoid receptor, is about 15 times higher than that of prednisolone. Clinical pharmacology and clinical data strongly indicate that budesonide capsules, at least partly, act topically. Patients with inflammatory bowel disease have been found to have a reduced bone mineral density (BMD). A two year multi-centre, open, randomized trial in 272 patients was conducted to compare the influence of treatment with budesonide capsules or prednisolone on BMD in subject’s with Crohn’s disease affecting the ileum and/or the ascending colon. Statistically significantly less BMD of the lumbar spine was discovered with budesonide (0.011g/cm²) than prednisolone (0.04g cm²) in steroid-naïve patients. Treatment with budesonide (as needed up to 9 mg/day) or prednisolone (as needed up to 40 mg/day) in this study were both found to be safe and generally well tolerated. However, subjects treated with budesonide experienced significantly less glucocorticosteroid side effects than subjects treated with prednisolone.

**Effect on Haematological Parameters**

Glucocorticosteroids increase blood neutrophils and decrease blood basophils, eosinophils and lymphocytes within 4 to 6 hours after administration to healthy volunteers. These effects are due to a transient redistribution of cells, with the values returning to normal within 24 hours. Treatment with budesonide capsules in daily doses of 3 to 15 mg for 8 weeks, and 3 to 6 mg for up to 1 year, affect circulating cells and systemic inflammatory markers (C-reactive protein and orosomucoid) to a very small extent.

**Pharmacokinetics**

**Absorption and Distribution**

The site of uptake of controlled ileal release budesonide has been studied in healthy subjects and in patients with Crohn’s disease using inert 111In-labelled pellets as markers of intestinal transit. These studies indicate that budesonide is continuously released during passage through the small intestines and ascending colon. In one study in 8 healthy subjects, 68% and 69% of totally absorbed budesonide was absorbed in the ileum and ascending colon in a fasting and fed state, respectively. In another study in 6 healthy subjects, the absorption values immediately before and after breakfast were 58% and 52%, respectively. In a study in
6 patients with Crohn’s disease, 42% of budesonide, following administration after breakfast, was absorbed in the ileum and ascending colon. The lower mean value in patients as compared to healthy subjects may be explained by two patients, where the residence time in the ileum and the ascending colon was extremely short (1.6 h) as compared to an average of 13.8 h and 17.3 h in the rest of the patients and healthy volunteers, respectively.

The volume of distribution of budesonide in healthy subjects (range 2.2 to 3.9 L/kg), and in patients with CD (range 1.6 to 3.2 L/kg), is large and the plasma protein binding (85-90%) is extensive compared with other synthetic glucocorticosteroids. The free volume of distribution (i.e., the ratio between volume of distribution and free plasma) is high for budesonide. This reflects a high tissue affinity of the compound. Following oral dosing of budesonide capsules 9 mg, mean maximal plasma concentration is approximately 5-10 nmol/L, attained at 3-5 hours.

**Metabolism and Excretion**

The half-life of budesonide after intravenous administration is 1.9-3.6 h in adults and shorter, 1.5 h, in children. In patients with CD, the plasma half-life after intravenous dosing is 2.4 h (range 2.1 to 2.8 h). After oral dosing with budesonide capsules, the mean terminal half-life for budesonide ranges between 3.0 and 5.1 h, with no discernible difference between patients and healthy subjects. Elimination of budesonide given as budesonide capsules is rate limited by its absorption, and the terminal half-life averages 4 hours.

The systemic clearance of budesonide (0.9-1.4 L/min) is high compared with other glucocorticosteroids. After oral dosing of budesonide capsules, the systemic availability in healthy subjects is approximately 10%, which is similar to oral dosing of plain micronized budesonide (6-13%) indicating complete absorption. After a single dose of budesonide capsules in patients with active CD, the systemic availability ranges from 12-20%. In healthy subjects the corresponding figures are 9-12%.

In human volunteers who inhaled tritiated budesonide, 31.8 ± 7.5% of the discharged radioactivity was recovered in the urine (within 96 hours of administration) while during the same period, 15.1 ± 4.3% of the radioactivity could be recovered in the faeces. In those subjects who took the compound orally, 45.0 ± 5.0% was recovered in the urine, 29.6 ± 2.5% in the faeces. Virtually no unchanged budesonide is excreted in the urine.

*In vitro* studies with human liver have shown that budesonide is rapidly metabolized to more polar compounds than the parent drug. Two major metabolites have been isolated and identified as 6β-hydroxybudesonide and 16α-hydroxyprednisolone. The glucocorticoid activity of these two metabolites was at least 100-fold lower than the parent compound as shown in the rat ear edema test. No qualitative differences between the *in vitro* and *in vivo* metabolic patterns could be detected. Negligible biotransformation was observed in human lung and serum preparations.
TOXICOLOGY

A complete toxicological program (acute, chronic, reproduction, mutagenicity and carcinogenicity studies) has been performed with budesonide after various routes of administration, such as oral, subcutaneous, epicutaneous and inhalation. Most of the studies were performed in rats and dogs. The toxicity of budesonide capsules, with a focus on the gastrointestinal tract, has been studied in Cynomolgus monkeys after repeated oral administration.

**Acute Toxicity**

The acute toxicity studies with budesonide after oral and subcutaneous administration are summarized in Table 2.

**Table 2. Acute Toxicity Of Budesonide In Mice And Rats**

<table>
<thead>
<tr>
<th>Species</th>
<th>Sex</th>
<th>Route</th>
<th>LD$_{50}$ (mg/kg) after 3 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse</td>
<td>Male</td>
<td>s.c.</td>
<td>35 ± 18</td>
</tr>
<tr>
<td>Mouse</td>
<td>Male</td>
<td>p.o.</td>
<td>&gt; 800</td>
</tr>
<tr>
<td>Mouse</td>
<td>Female</td>
<td>p.o.</td>
<td>&gt; 800</td>
</tr>
<tr>
<td>Rat</td>
<td>Male</td>
<td>s.c.</td>
<td>15.1 ± 4.4</td>
</tr>
<tr>
<td>Rat</td>
<td>Female</td>
<td>s.c.</td>
<td>20.3 ± 7.1</td>
</tr>
<tr>
<td>Rat</td>
<td>Male</td>
<td>p.o.</td>
<td>≈ 400</td>
</tr>
</tbody>
</table>

Surviving animals exhibited a marked decrease in body weight gain.

**Toxicity After Repeated Administration**

Table 3 summarizes the toxicity information from studies in which rats, rabbits and dogs received repeated oral, inhalation and subcutaneous administration of plain budesonide, as well as the toxicity of budesonide capsules after once daily oral administration of doses up to 5000 µg/kg/day, for 4 to 26 weeks to monkeys.
<table>
<thead>
<tr>
<th>Species</th>
<th>Strain</th>
<th>No. And Sex per Group</th>
<th>No. of Dose Groups</th>
<th>Budesonide Formulation</th>
<th>Daily Dose Levels mg/kg</th>
<th>Route of Administration</th>
<th>Duration</th>
<th>Toxic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>Sprague-Dawley</td>
<td>6 males 6 females</td>
<td>4</td>
<td>plain</td>
<td>0.05 0.5 5.0 50.0</td>
<td>p.o.</td>
<td>1 month</td>
<td>Atrophy of adrenal gland and lymphoid system. Gastric ulceration.</td>
</tr>
<tr>
<td>Rat</td>
<td>Wistar</td>
<td>10 males 10 females</td>
<td>3</td>
<td>plain</td>
<td>0.02 0.10 0.2-0.5</td>
<td>inhalation</td>
<td>3 months</td>
<td>Hair loss dose related. Reduction in lymphocytes, leukocytes, increase in neutrophils. In high dose group, reduced adrenal, thymic, splenic and hepatic weights. No pulmonary impairment observed.</td>
</tr>
<tr>
<td>Rat</td>
<td>Wistar</td>
<td>40 males 40 females</td>
<td>3</td>
<td>plain</td>
<td>0.005 0.01 0.05</td>
<td>inhalation</td>
<td>12 months</td>
<td>As above.</td>
</tr>
<tr>
<td>Rabbit</td>
<td>New Zealand White</td>
<td>3 males 3 females</td>
<td>2</td>
<td>plain</td>
<td>0.025 0.1</td>
<td>s.c.</td>
<td>1 month</td>
<td>High dose caused slight liver mass increase, slight decrease in adrenal mass, thymal regression.</td>
</tr>
<tr>
<td>Dog</td>
<td>Beagle</td>
<td>1 male 1 female</td>
<td>3</td>
<td>plain</td>
<td>0.01 0.1 1.0</td>
<td>p.o.</td>
<td>1 month</td>
<td>High dose - typical steroid effects - adrenal, lymphoid system atrophy, increased fat in myocardium, glycogen in liver.</td>
</tr>
<tr>
<td>Dog</td>
<td>Beagle</td>
<td>2 males 2 females</td>
<td>3</td>
<td>plain</td>
<td>0.02 0.06 0.2</td>
<td>inhalation</td>
<td>6 weeks</td>
<td>High dose - induced thymal atrophy, adrenal atrophy. No changes in respiratory system observed.</td>
</tr>
<tr>
<td>Species</td>
<td>Strain</td>
<td>No. And Sex per Group</td>
<td>No. of Dose Groups</td>
<td>Budesonide Formulation</td>
<td>Daily Dose Levels</td>
<td>Route of Administration</td>
<td>Duration</td>
<td>Toxic Effects</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>-----------------------</td>
<td>--------------------</td>
<td>------------------------</td>
<td>-------------------</td>
<td>-------------------------</td>
<td>----------</td>
<td>----------------</td>
</tr>
<tr>
<td>Dog</td>
<td>Beagle</td>
<td>5 males 5 females</td>
<td>3</td>
<td>plain</td>
<td>0.20 0.60 2.00</td>
<td>inhalation</td>
<td>6 months</td>
<td>High dose - decreased plasma cortisol, cortical atrophy of the adrenal gland, thymal regression. Slight visceral obesity.</td>
</tr>
<tr>
<td>Dog</td>
<td>Beagle</td>
<td>5 males 5 females</td>
<td>3</td>
<td>plain</td>
<td>0.20 0.60 2.00</td>
<td>inhalation</td>
<td>12 months</td>
<td>High dose - obesity, alopecia, females showed no evidence of estrous cycle. Systemic steroid effects - lymphoid and adrenal atrophy.</td>
</tr>
<tr>
<td>Monkey</td>
<td>Cynomolgus</td>
<td>2 males 2 females</td>
<td>4</td>
<td>CIR capsules</td>
<td>0 0.1 0.33 1.0</td>
<td>p.o.</td>
<td>4 weeks</td>
<td>No toxic effects attributable to treatment were observed.</td>
</tr>
<tr>
<td>Monkey</td>
<td>Cynomolgus</td>
<td>4 males 4 females</td>
<td>4</td>
<td>CIR capsules</td>
<td>0 0.5 2.0 5.0</td>
<td>p.o.</td>
<td>26 weeks</td>
<td>Medium/high dose - body weight change, slightly reduced cortisol levels. High dose - slightly higher liver and lower adrenal weight, elevated glucose levels in females, elevated plasma protein and reduced cellularity in males.</td>
</tr>
</tbody>
</table>

All effects observed were consistent with those expected during prolonged glucocorticosteroid exposure. CIR - Controlled Ileal Release
Teratology and Reproduction Studies

Effects on Pregnancy

*Rat*

Daily doses of 20, 100, and 500 µg/kg body mass were administered subcutaneously to pregnant rats during days 6-15 of gestation. In the high dose group, all of the rats showed a deteriorated general condition including piloerection, drowsiness, decreased food consumption and decreased body mass gain. Fetal loss was increased and pup masses decreased in comparison to the control group. The frequency of fetal abnormalities was also increased. Doses in excess of 100 µg/kg must be considered teratogenic in the rat.

Daily doses of 0.01, 0.05 and 0.1 - 0.25 mg/kg were administered by inhalation to pregnant rats during days 6-15 of gestation. At the highest dose a slight significant reduction in fetal weight gain was observed, but there was no evidence of any effect on fetal development attributable to budesonide at any dose level.

*Rabbit*

Daily doses of 5, 25, and 125 µg/kg body mass were administered subcutaneously during days 6-18 of gestation. In the low and medium dose groups, food consumption and body mass gain were decreased during the fourth gestational week. Some does also showed signs of diarrhea and vaginal bleeding. In the high dose group, all does aborted at the end of the gestation period. In the medium dose group, a marked increase in the frequency of abnormalities, mainly skeletal defects, was observed. Most commonly, defects were skull and vertebral abnormalities.

Effects on Fertility and General Reproductive Performance

*Rat*

To evaluate the effect of budesonide on fertility and general reproductive performance, daily doses of 0.01, 0.05, 0.19 µmol/kg were given subcutaneously to males for 9 weeks prior to and throughout mating. Females received the same doses for two weeks before, throughout gestation and up to 21 days postpartum. The offspring of the high dose group showed a decrease of peri- and post-natal viability. Dams showed a decrease in body mass gain.

Mutagenicity Studies

Budesonide showed no mutagenic activity in the Ames Salmonella/microsome plate test or in the mouse micronucleus test.

Carcinogenicity

The carcinogenic potential of budesonide was evaluated in long term mouse and rat studies.
Chronic Drinking Water Study in Mice

Budesonide was administered in the drinking water for 91 weeks to three groups of CD<sup>®</sup>-1 mice at dose levels of 10, 50 and 200 µg/kg/day.

A statistically significant dose-related decrease in survival was noted for the males only. All other evaluation criteria were comparable in all groups. Upon microscopic examination, a variety of spontaneous lesions was observed which were not related to treatment. No carcinogenic effect was present.

Chronic Drinking Water Study (104 Weeks) with Budesonide in Rats

Three rat carcinogenicity studies have been performed. In the first study, budesonide was administered for 104 weeks in doses of 10, 25 and 50 µg/kg/day.

A small but statistically significant increase in gliomas was noted in male animals from the high dose group. These results were considered equivocal since the S-D rat is very variable with regard to spontaneous glioma incidence.

To elucidate these results, two further 104 week carcinogenicity studies with budesonide 50 µg/kg/day were performed, one using male S-D rats, and one using male Fischer rats (which have a lower and less variable incidence of gliomas). Prednisolone and triamcinolone acetonide were used as reference glucocorticoids in both studies.

The results from these new carcinogenicity studies in male rats did not demonstrate an increased glioma incidence in budesonide treated animals, as compared to concurrent controls or reference glucocorticosteroid treated groups.

Compared with concurrent control male S-D rats there was also an increased incidence of liver tumours in the mid- and high-dose groups in the original study. This finding was confirmed in all three steroid groups (budesonide, prednisolone, triamcinolone acetonide) in the repeat study in male S-D rats thus indicating a class effect of glucocorticosteroids.

Toxicological Effects on the Gastrointestinal Tract

There are few apparent toxicological effects of low doses of budesonide noted on the gastrointestinal tract which, together with the liver, is a body organ system that will be exposed to high concentrations of budesonide after oral administration of the drug.

Oral administration of budesonide to rats for 1 month disclosed no adverse effects on the gastrointestinal tract at doses up to 500 µg/kg although at 500 µg/kg atrophy of spleen and adrenals were noted as well as fat deposition in the liver, effects typical of a glucocorticoid. At 5000 µg/kg, ulcerations and bleeding of the gastrointestinal tract were noted as well as pronounced systemic toxicity.

Administration of budesonide, in the drinking water, to rats for 3 months, revealed at necropsy, stomach changes including raised white areas or nodules, dark ulcer-like areas, dark or dark-red foci and dark depressed areas among the female treated rats (50-700 µg/kg) and in
one high-dosed male out of ten (700 µg/kg). No changes were noted in the control animals (both sexes). Similar stomach changes were also found in a three-month drinking water study in mice. No changes were noted at 10 µg/kg but these stomach changes were observed at 50 µg/kg in both sexes. However, no stomach lesions were reported among the high dosed male mice (700 µg/kg). A few control animals were also affected.

In a 12-month inhalation study (mainly oral/gastrointestinal deposition and absorption) in rats, histological examination disclosed the absence of bile duct hyperplasia of the liver at 50 µg/kg (high dose). This is a glucocorticoid effect since bile duct hyperplasia is a normal finding in the senescent rat. There were no adverse effects on the gastrointestinal tract at 50 µg/kg.

Budesonide given orally to dogs for 1 month disclosed a slight liver enlargement with increased glycogen deposition at 100 µg/kg. No adverse effects were noted on the gastrointestinal tract. A 12-month oral inhalation study in dogs (doses between 20-200 µg/kg) disclosed increased liver weight and glycogen deposition at 200 µg/kg. There were no adverse effects on the gastrointestinal tract at any dose level.

Oral administration of 100-1000 µg/kg/day budesonide capsules to Cynomolgus monkeys for 4 weeks disclosed no treatment-related clinical signs. Budesonide capsules given orally to Cynomolgus monkeys for 26 weeks disclosed no effects on the gastrointestinal tract at doses up to 5000 µg/kg/day.
BIBLIOGRAPHY

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Lofberg R, Danielsson Å, Salde L.  

IMPORTANT: PLEASE READ

PART III: CONSUMER INFORMATION

Pr: BUDESONIDE
Budesonide Controlled Ileal Release Capsules 3 mg

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

ABOUT THIS MEDICATION

What the medication is used for:
BUDESONIDE Capsules are used to treat Crohn’s disease, an inflammatory bowel disease, in the small bowel and the first part of the large bowel. BUDESONIDE Capsules reduce the inflammation and related symptoms of this disease, such as stomach pain and diarrhea.

What it does:
BUDESONIDE is an anti-inflammatory drug which belongs to the steroid family of drugs. BUDESONIDE Capsules have been shown to help reduce the production of substances and interfere with the processes responsible for the inflammatory response, thereby reducing the inflammation and improving related symptoms.

When it should not be used:
Do not use BUDESONIDE Capsules (budesonide) if you:
• have any infection(s) in the rest of the body
• have tuberculosis
• are allergic to any of the ingredients in BUDESONIDE Capsules (see What the medicinal ingredient is and What the nonmedicinal ingredients are).

What the medicinal ingredient is:
budesonide

What the nonmedicinal ingredients are:
The nonmedicinal ingredients are: acetyltributyl citrate, dimethicone (Antifoam M), ethylcellulose, gelatin, iron oxide, methacrylic acid copolymer, polysorbate 80, sodium lauryl sulphate, sugar spheres (sucrose and maize starch), talc, titanium dioxide and triethylcitrate.

What dosage forms it comes in:
Capsules 3 mg
Each capsule is filled with a large number of small grains. When swallowed, the medicine passes through the stomach intact, and is gradually released in the small bowel.

WARNINGS AND PRECAUTIONS

BEFORE you use BUDESONIDE Capsules, talk to your doctor or pharmacist if:
• you have any health problems such as liver disease, brittle bones (osteoporosis), stomach ulcer, high blood pressure, cataracts or any other eye diseases, diabetes or a family history of diabetes or glaucoma
• you are about to have or plan to have any operation
• you are taking or have taken steroid medicines within the past several months
• you are pregnant or plan to become pregnant
• you are breastfeeding or planning to breastfeed.
BUDESONIDE Capsules (budesonide) is excreted in human breast milk. Talk to your doctor.

Avoid exposure to chicken pox and measles.

Regular ingestion of grapefruit or its juice should be avoided during treatment with BUDESONIDE Capsules, since intake of grapefruit can increase the amount of budesonide that is absorbed from the gut (other fruits such as orange or apple do not influence the uptake of budesonide).

Do not stop using BUDESONIDE Capsules until your doctor tells you to.

Tell your doctor if your symptoms become worse while you are using BUDESONIDE Capsules.

BUDESONIDE Capsules have been specifically prescribed for your current condition. Do not use it for other problems unless your doctor tells you to do so.

Never give your medicine to someone else.

INTERACTIONS WITH THIS MEDICATION

Tell your doctor about all the medications you are taking, including ones you can buy without a prescription.

Drugs that may interact with BUDESONIDE Capsules include:
• estrogens and oral contraceptives
• ketoconazole, fluconazole, itraconazole, miconazole
• medicines used to treat HIV such as ritonavir, cobicistat
• cyclosporin
• erythromycin, troleandomycin
PROPER USE OF THIS MEDICATION

Take all doses of BUDESONIDE Capsules, as recommended by your doctor, even if you feel better. The full effect of BUDESONIDE Capsules is usually achieved within 2-4 weeks.

BUDESONIDE Capsules should be swallowed whole with water. It is important that the contents of the capsules are not crushed or chewed. BUDESONIDE Capsules should be taken before meals.

**Usual adult dose:**

**Acute Treatment**
The usual dose for treatment of acute symptoms is 9 mg per day, for up to 8 weeks. The dose can be given once daily as three 3 mg capsules in the morning.

**Long Term Treatment**
The usual starting dose for long-term treatment is 6 mg per day. Take two 3 mg capsules in the morning, before breakfast. Your doctor may want to change the dose, depending on the activity of your disease.

**Do not stop taking BUDESONIDE Capsules on your own.**
Your doctor may want to slowly reduce your dose, especially if you have been using BUDESONIDE Capsules for a long time.

**Note:** If your medication has been changed from “cortisone” tablets (such as prednisone, prednisolone or methylprednisolone) to BUDESONIDE Capsules you may temporarily experience symptoms, that may have bothered you when you first started taking “cortisone”, e.g. rash, pain in muscles and joints. If any of these symptoms bothers you, or symptoms such as headache, tiredness, nausea or vomiting occur, please contact your doctor.

**Missed Dose:**
If you miss a dose, just take the next dose on time. Never take a double dose of BUDESONIDE Capsules to make up for missed doses.

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

SIDES EFFECTS AND WHAT TO DO ABOUT THEM

BUDESONIDE Capsules, like any medication, may cause side effects in some people.

Medicines like BUDESONIDE Capsules called corticosteroids can have various effects on your body. They can

- change the normal production of steroid hormones in your body.
- change the bone mineral density (thinning of the bones that can lead to osteoporosis and fractures), when used for long term.
- cause glaucoma (increased pressure in the eye that can lead to vision problems).
- reduce the function of the adrenal gland (that can lead to decrease of hormone production).

Other side effects that do occur are usually mild to moderate. However, be sure to tell your doctor if any of the following side effects bother you: swelling of the face; indigestion; menstrual problems; muscle cramps; trembling; rapid or irregular heartbeats; heartburn; itching and skin rash; skin discoloration resulting from bleeding beneath the skin. Low potassium levels in the blood may also occur.

Although rare, symptoms of steroid withdrawal i.e. fatigue, muscle or joint aches may occur if BUDESONIDE Capsules are stopped too quickly.

<table>
<thead>
<tr>
<th>Symptom / effect</th>
<th>Talk with your doctor or pharmacist</th>
<th>Stop taking drug and call your doctor or pharmacist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>Behavioural changes such as depression, insomnia and mood swings</td>
<td>√</td>
</tr>
<tr>
<td>Uncommon</td>
<td>Unintentional movements or extreme restlessness possibly accompanied by muscle spasms or twitching</td>
<td>√</td>
</tr>
<tr>
<td>Rare</td>
<td>Behavioural changes such as anxiety, and aggression</td>
<td>√</td>
</tr>
</tbody>
</table>
SERIOUS SIDE EFFECTS, HOW OFTEN THEY HAPPEN AND WHAT TO DO ABOUT THEM

<table>
<thead>
<tr>
<th>Symptom / effect</th>
<th>Talk with your doctor or pharmacist</th>
<th>Stop taking drug and call your doctor or pharmacist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare</td>
<td>Clouding of the eye’s natural lens including the back of the lens leading to blurred vision</td>
<td>√</td>
</tr>
<tr>
<td>Very rare</td>
<td>Severe allergic reactions with symptoms such as rash, swelling of tissues, and/or difficulties in breathing.</td>
<td>√</td>
</tr>
</tbody>
</table>

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

HOW TO STORE IT

BUDESONIDE Capsules come in a container with a drying agent fitted in the cap. Always keep BUDESONIDE Capsules in the container. If you don’t, moisture from the air may damage the capsules.

Store BUDESONIDE Capsules at room temperature (15-30°C) and in a dry place. Do not keep them in the bathroom medicine cabinet or other warm, moist places. Do not use BUDESONIDE Capsules after the expiry date marked on the package.

Remember to keep BUDESONIDE Capsules well out of the reach and sight of children.

REPORTING SUSPECTED SIDE EFFECTS

You can report any suspected adverse reactions associated with the use of health products to the Canada Vigilance Program by one of the following 3 ways:

- Report online at www.healthcanada.gc.ca/medeffect
- Call toll-free at 1-866-234-2345
- Complete a Canada Vigilance Reporting Form and:
  - Fax toll-free to 1-866-678-6789, or
  - Mail to: Canada Vigilance Program
    Health Canada
    Postal Locator 0701E
    Ottawa, Ontario
    K1A 0K9

Postage paid labels, Canada Vigilance Reporting Form and the adverse reaction reporting guidelines are available on the MedEffect™ Canada Web site at www.healthcanada.gc.ca/medeffect.

NOTE: Should you require information related to the management of side effects, contact your health professional. The Canada Vigilance Program does not provide medical advice.

MORE INFORMATION

NOTE: This CONSUMER INFORMATION leaflet provides you with the most current information at the time of printing.

The most current information, the Consumer Information Leaflet, plus the full Product Monograph, prepared for health professionals can be found at:
www.hc-sc.gc.ca/dhp-mps/prodpharma/databasdon/index-eng.php
or by contacting the sponsor, Tillotts Pharma GmbH, at:
Customer Inquiries – 1-855-831-5420.

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Importer/Distributor:
C.R.I.
4 Innovation Drive
Dundas, Ontario
L9H 7P3

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