

Update on Managing Canine Hyperadrenocorticism

UNDERSTAND

Hyperadrenocorticism (HAC, Cushing's syndrome) describes the clinical manifestation of chronic exposure to excess levels of glucocorticoids- primarily cortisol. It is relatively common in older dogs, increasingly recognized in cats, and rare in other domestic animals. The symptoms of HAC are the results of excessive, chronic production of circulating glucocorticoids by the adrenal glands. Left untreated, dogs experience a progressive decrease in overall quality of life and are predisposed to life-threatening conditions such as hypertension, chronic infections, glomerular disease and pulmonary thromboembolism.

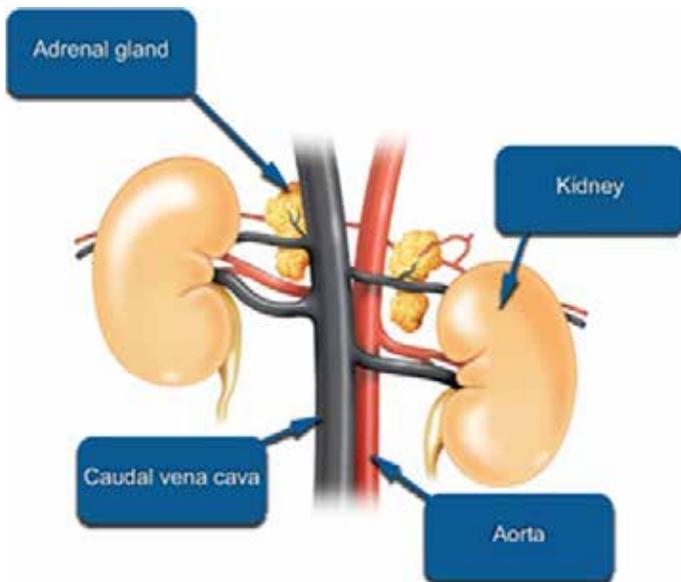


Figure 1: Normal adrenal anatomy.

Each adrenal gland is divided into two functionally distinct parts: the cortex and medulla. The adrenal cortex comprises 80 – 90% of the entire gland and produces glucocorticoids, mineralocorticoids, and androgens. The medulla comprises 10 – 20% of the adrenal gland and produces catecholamines.^{1,2} Cortisol is released by the adrenal gland in response to stress. A classical negative feedback loop operates to regulate endogenous production.

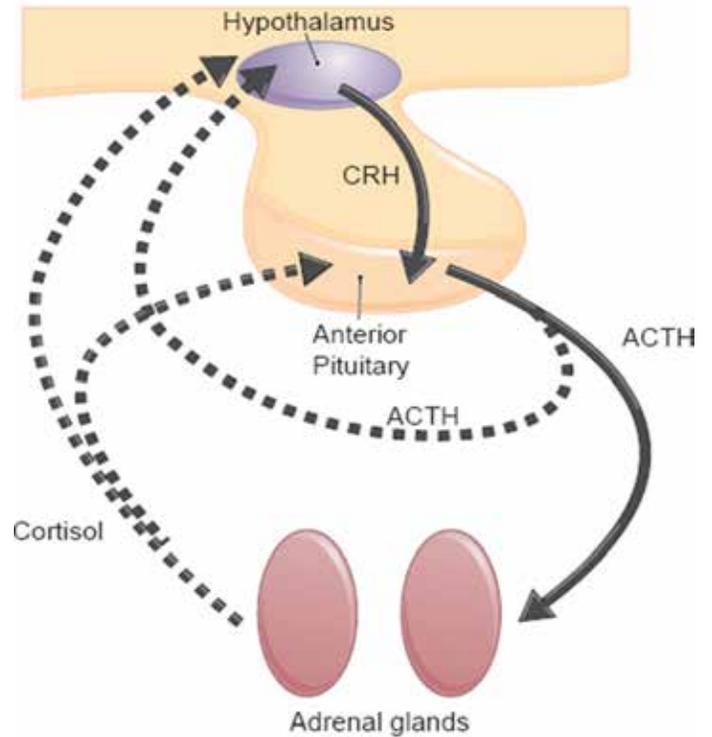


Figure 2: Hypothalamic Pituitary Adrenal (HPA) axis in a healthy dog. Note - the solid line is the positive feedback (direct release of hormones) and the dotted line represents the negative feedback; (mechanism by which the hormone release is turned off).

The hypothalamus secretes corticotrophin releasing hormone (CRH) that travels to the anterior pituitary, regulating the secretion of adrenocorticotrophic hormone (ACTH), which regulates the secretion of cortisol by the adrenal cortex. Both cortisol and ACTH have negative feedback effects on higher centers.

HAC can be spontaneous or iatrogenic. The spontaneous cases are associated with a tumor in either the pituitary or the adrenal gland. Pituitary tumors are responsible for 80 – 85% of HAC cases. The majority of pituitary tumors are microadenomas (< 1 cm) while 10 – 20% are macroadenomas (> 1 cm). Patients with macroadenomas are prone to neurological signs. In pituitary-dependent hyperadrenocorticism (PDH), a tumor in the

anterior pituitary autonomously secretes ACTH in excess, which triggers excessive cortisol production. In adrenal-dependent hyperadrenocorticism (ADH), the adrenal tumor secretes cortisol autonomously. Adrenal tumors have a 50% chance of malignancy. Determining the tumor location (adrenal vs. pituitary) allows for : 1) determination of the proper treatment, 2) a more specific prognosis, and 3) greater prediction of additional clinical signs.^{1,2} Atypical HAC is a controversial diagnosis with an unclear etiology/pathogenesis. These dogs have a history, physical exam findings, clinical pathology abnormalities, and adrenal imaging consistent with HAC yet routine screening tests are negative.^{3,4} The 2012 ACVIM consensus statement for diagnosing HAC suggests that the current reference ranges and cut-off values for HAC screening tests introduced in the 1970s and 1980s should be re-evaluated and possibly adjusted.⁵ If clinical suspicion of HAC is high and other disease processes have been ruled out, then re-evaluation/testing should be performed 30-90 days later.

IDENTIFY

Cortisol has diverse effects on the body that can lead to a wide variety of clinical signs. This can result in changes to bone, muscle, skin/hair coat, renal system, liver, CNS, blood production, and immune response. Clinical signs associated with HAC are described in the lists below.

Common clinical signs:

- Polyuria/polydipsia
- Polyphagia
- Panting
- Pot-bellied appearance
- Alopecia
- Associated secondary dermatologic conditions

Other clinical signs:

- Muscle wasting
- Hyperglycemia (insulin resistance)
- Neurologic signs (pituitary macroadenoma)
- Hypertension
- Redistribution of adipose tissue

- Proteinuria
- Calcinosis Cutis
- Recurrent infection (UTI, pyoderma)

HAC is rarely seen in dogs less than 6 years of age. Males and females are equally represented, as well as many breeds. There are some breeds that appear to have increased predilection, such as Boxers, Poodles, Dachshunds, various terrier breeds, German shepherd dogs, and Labradors.^{1,2}

Dogs often present with a vague history; clinical signs may be overlooked by the owner, or presented as “age related changes”. A thorough history and clinical examination are important to make a diagnosis of Cushing’s syndrome.



Figure 3: A dog with hyperadrenocorticism. Note the muscle wasting on hips and muscles of mastication, marked alopecia and secondary skin changes (including calcinosis cutis) are noted.



Figure 4: Close up view of Calcinosis cutis. Photo credit: Timothy Smaha, DVM

DIAGNOSE

HAC is a clinical diagnosis that starts in the exam room and is supported by laboratory data. Since clinical signs are sometimes subtle, a thorough history is necessary. It is important to perform endocrine testing only when clinical signs are present, as treatment is heavily based on response of clinical signs to medical management.

Findings on routine laboratory screening tests can be variable in HAC patients. The CBC can show increases in hematocrit and thrombocytosis (>600,000), which may contribute to the hypercoagulability. Stress leukograms are common; however, remember immunosuppression is possible in dogs with HAC, and the clinical pathology may differ. Routine biochemical profile findings may include hyperglycemia (likely due to gluconeogenesis and insulin resistance), increased alkaline phosphatase (ALKP), cholesterol and triglycerides.^{1,2} Occasionally, hyperphosphatemia can be seen, which has been associated with decreased survival times (statistically found to be a negative prognostic indicator).⁶ Urinalysis often reveals a low urine specific gravity (often less than 1.010), but not all dogs will have this finding. Glucosuria and proteinuria can be seen, and occult urinary tract infections are common and often require urine culture and sensitivity to be successfully diagnosed and treated.^{1,2}

Before proceeding with endocrine testing for HAC, ensure the patient has clinical signs consistent with HAC that cannot be explained by other disease conditions. For example, an elevated ALKP in isolation, with no clinical signs, is not sufficient to pursue endocrine testing. The 2012 ACVIM consensus states, “the primary indication for pursuing a diagnosis of HAC is the presence of one or more of the common clinical signs and physical examination findings. It is important to keep in mind HAC is a clinical diagnosis.”⁵

In the diagnosis of HAC, there are two questions to answer: 1) is HAC present? 2) what is the source? To answer the first question,

the clinician needs to demonstrate either an increased cortisol production, or a decreased sensitivity of the HPA axis to negative glucocorticoid feedback. To avoid cross reactivity with the assay antibodies, exogenous steroid use should be discontinued for at least 24 hours prior to any endocrine testing.

Screening tests for HAC include the following: the urinary cortisol:creatinine ratio (UCCR), the low-dose dexamethasone suppression test (LDDST), and ACTH stimulation test. All of these tests have negative and positive attributes; there is no perfect test.⁵

Any screening test may be negative in a patient with HAC. If a test is negative but suspicion for HAC remains, another test should be performed. If more than one test is negative, either consider the patient does not have HAC; or alternatively, re-evaluate the patient in 3 – 6 months if clinical signs progress.

Test	Sensitivity (%)	Specificity (%)
ACTH stimulation	Less than ideal (80-95)	Good (86-91)
LDDST	Excellent (85-100)	Poor (44-73)
UCCR	Excellent (75-100)	Poor (24-77)
Poor Sensitivity → patient re-resented / referred Poor Specificity → inappropriate lifelong therapy		

Figure 5: Sensitivity and Specificity of current tests used to diagnose HAC.^{1,2,5}

Urinary Cortisol:Creatinine Ratio

Creatinine is excreted in the urine at a constant rate; cortisol is not. The UCCR is a sensitive test to detect cortisol hypersecretion. It is imperative the dog is not stressed for the urine sample collection. To minimize stress, the owner should collect free catch samples for 1-3 days at home and bring to the practice; first morning samples are ideal. Samples can be pooled to increase chances of observing an elevated cortisol due to daily variation. Stress and non-adrenal illness can cause increases in urine cortisol levels; false positives can occur – specificity can be as low as 20 – 25%.

However, a normal ratio can be considered truly negative and HAC can be ruled out.^{1, 2, 5}

Low-Dose Dexamethasone Suppression Test

The LDDST tests the negative feedback system. If the system is intact, there will be suppression of CRH, ACTH, and ultimately cortisol production at 4 & 8 hours. A normal dog will suppress cortisol production within 2 – 3 hours and remain suppressed for 16 – 24 hours or more. Collect a baseline sample then immediately administer 0.01mg/kg of dexamethasone IV. Additional samples are taken at 4 hours and 8 hours. The LDDST is considered consistent with HAC if the 8 hour cortisol is > 1.4 ug/dL. An inverse pattern, where the 4 hour post-dexamethasone was increased, but the 8 hour post-dexamethasone was below the cut-off value, has also been seen in PDH and warrants further testing for HAC.^{1, 2, 5}

The LDDST has a high sensitivity (85 – 90%), so a negative result provides a high confidence the dog is normal. Unfortunately, it has a low specificity, so a positive result is not confirmatory for HAC. False positives will occur in 27 – 66% of dogs as a result of non-adrenal illness or stress. This test should not be used if a patient has a history of exogenous steroid administration.^{1, 2, 5}

A positive LDDST can help differentiate PDH from ADH if the 4 hour sample is < 1.4 ug/dL or if there is at least 50% suppression from baseline cortisol levels at the 4 hour or 8 hour time point.^{1, 2, 5}

ACTH Stimulation Test

The ACTH stimulation test evaluates the adrenocortical reserve. Dogs with hyperplastic

adrenal tissue have exaggerated cortisol response to ACTH. Collect a baseline sample then administer 5 µg/kg (max dose 250 µg) synthetic ACTH IV or IM (IV is the preferred method). Peak cortisol excretion occurs 60 – 90 minutes after injection. A 2nd blood sample is collected at 1 hour post ACTH administration. A diagnosis for HAC is made when cortisol levels post stimulation are greater than 22 µg/dL.

A recently-published study in dogs authenticated a 1 µg/kg dose for ACTH stimulation tests for monitoring patients receiving either mitotane or trilostane; this dose cannot be used for diagnosing HAC. Caveats to using the low dose for monitoring include the following: the dose has to be administered IV, and the post stimulation blood sample must be taken at the 60 minute mark.⁷

Differentiation

Once a diagnosis of HAC has been confirmed, determining the source (pituitary or adrenal tumor) is the next step. The LDDST may be useful in differentiation in approximately 60% of dogs with PDH.^{1, 2, 5} If this does not occur, then a secondary test is needed to differentiate PDH from ADH. The most common modality for differentiation is imaging, with ultrasound being used in the majority of cases. Endogenous ACTH may also be measured as it would only be present in dogs with PDH. Pre-emptive collection and freezing of an EDTA plasma sample at collection of LDDST baseline cortisol sample may spare additional exam appointments. Careful handling of the sample is necessary to get reliable results with the endogenous ACTH assay and warrants a call to your preferred reference laboratory for further instructions.

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TREAT

Treatment of HAC may be achieved by surgery, pituitary irradiation, or medical management. Transsphenoidal hypophysectomy (THS) can be offered to dogs with PDH and in good clinical condition. The surgery is effective with a median survival rate of 86% and remission for up to seven years.^{8,22} It is not widely available and can be cost prohibitive for many clients. Inoperable pituitary tumors can be treated by radiotherapy. Radiotherapy is effective in reducing the size of such pituitary tumors, but with a variable delay, from 1 to 16 months. The reduction in size is gradual in onset, but can continue for a year or more after completion of therapy. The improvement in clinical signs of HAC is associated with the reduced pituitary ACTH secretion.⁸ The treatment of choice of unilateral ADH is adrenalectomy. Successful removal eliminates both the tumor and the associated clinical signs of glucocorticoid excess without the need for lifelong medication. The median survival time after adrenalectomy is about 2 years, although some dogs survive more than 4 years.⁸

Surgery and radiotherapy are complicated procedures and only available at a few specialty centers, therefore medical management is often the most practical and approachable treatment choice. Four options for medical management of HAC include mitotane, selegiline, ketoconazole, and trilostane.

Mitotane (Lysodren[®], Bristol Myers Squibb) is not approved for use in dogs, but for many years was the available choice for managing HAC in dogs. It is a human cytotoxic/anti-neoplastic drug that works by causing cellular death in the adrenal gland. Through this dose-related adrenal necrosis, cortisol secretion is decreased.

Selegiline Hydrochloride, L-Deprenyl Hydrochloride (Anipryl[®], Zoetis) is FDA approved for uncomplicated PDH. It increases dopamine concentration, which in turn down-regulates ACTH concentration. Efficacy is fairly low, with only about 10 -15% of patients showing improvement in clinical signs.¹

Ketoconazole is a fungistatic drug that blocks several enzymes in the P-450 enzyme system, thus effectively blocking the synthesis of glucocorticoids and androgens with negligible effects on mineralocorticoids. There is no FDA approved formulation of ketoconazole for use in the dog. For the treatment of HAC, it takes higher doses than for most yeast/fungal infections, and side effects can be significant. It is effective in about 50% of HAC cases at controlling clinical signs.¹

Trilostane, in the form of VETORYL[®] CAPSULES (trilostane), Dechra Veterinary Products, is the only FDA-approved drug for the treatment of both PDH and ADH in dogs. It is a short-acting, reversible enzyme inhibitor. It preferentially inhibits 3 β - hydroxysteroid dehydrogenase enzyme in the adrenal cortex, thus blocking the production of cortisol, and to a lesser extent (typically at higher doses), aldosterone and the sex hormones.^{9,10} The effect on aldosterone production is usually clinically insignificant at the doses required to control cortisol production in dogs. Effects only last as long as the half-life of the drug, so if over-suppression occurs at a particular dose, the drug can be discontinued, and hormone production usually returns to normal. The clinician can then decide to restart VETORYL Capsules at a lower dose or discontinue use if clinical symptoms of HAC do not return.

VETORYL CAPSULES DOSAGE, ADMINISTRATION, & MONITORING

HAC is a clinical disease and understanding the status of the clinical signs is crucial to properly interpret your monitoring test results. Any time you or your staff are speaking with an owner whose dog is on VETORYL Capsules therapy you should ask about the clinical status of the dog.

The approved dose for VETORYL Capsules is a range of 1 – 3 mg/lb (2.2 – 6.7 mg/kg).⁹ Always start low. If the calculated patient dose falls between currently available strengths, round the patient's dose down to a whole capsule. Available capsule sizes include 5 mg, 10 mg,

30 mg, 60 mg and 120 mg. For most patients, begin with once daily VETORYL Capsules dosing in the morning with food; food increases absorption of VETORYL Capsules by up to three times.

Close monitoring is essential when a patient is started on VETORYL Capsules. If the owner notices any changes or abnormalities, they should call the veterinarian immediately. Lethargy, weakness, anorexia, vomiting, and diarrhea are the most common adverse reactions. The first recheck should be done 10 – 14 days after starting VETORYL Capsules (sooner if there are concerns or problems).

Maximal suppression of cortisol production occurs 3 – 8 hours after administration of VETORYL Capsules. For monitoring, ACTH stimulation test should be performed 4 – 6 hours post administration. If the test is done too early or too late, the cortisol levels could be elevated, and the clinician may make an inappropriate dosage change. Always ensure the owner gave the VETORYL Capsules that morning and that the medication was given with food before performing monitoring tests. At the first recheck, blood work should include an ACTH stimulation test 4 – 6 hours post pill administration and a chemistry panel with electrolytes. A decrease in cortisol (from baseline) can be seen in 10 – 14 days; cortisol will continue to drop over the next several weeks, but not as dramatically. The post-ACTH stimulation cortisol target range for VETORYL Capsules patients is 1.45 – 9.1 µg/dL. This

initial monitoring should not be used for a dosage increase. Only use this information to identify if the patient is over-suppressed (the dose is too high).

Over-suppressed patients can present with weakness, lethargy, anorexia, and vomiting. This could be the result of a glucocorticoid and/or mineralocorticoid deficiency and needs to be addressed immediately. VETORYL Capsules should be discontinued, the patient should be evaluated, and monitoring tests performed to measure cortisol and serum electrolytes (in particular sodium and potassium). In the event of an Addisonian crisis, stop VETORYL Capsules and institute immediate symptomatic/supportive therapy as required. Hyponatremia, hyperkalemia, and a low sodium:potassium ratio (< 27) are typically present in patients having an Addisonian crisis due to mineralocorticoid deficiency. Some patients can experience cortisol withdrawal syndrome in the first 10 days of therapy. These patients display similar signs of oversuppression, but have normal levels of cortisol and serum electrolytes. These patients typically respond well to discontinuing VETORYL Capsules for approximately 7 days and then restarting at a lower dose.

Assuming all post-stimulation cortisol levels are appropriate, and no dose adjustments are made, a second ACTH stimulation test is done 30 days from the initiation of therapy, then at 90 days, and every 3 months thereafter. Any time a dose adjustment is made, a recheck ACTH

POST-ACTH SIM CORTISOL	DOSE ADJUSTMENT
< 1.45 ug/dL	Stop VETORYL Capsules for 5-7 days. Restart at 25-50% of previous dose once signs of HAC recur and canine has been off of VETORYL Capsules for 5-7 days
2.0-5.4 ug/dl	Continue present dose
5.41-9.1 ug/dl	Continue present dose if clinical signs are well controlled If clinical signs still evident, increase dose by 10 mg or 25% and recheck ACTH stim 10-14 days later.
> 9.1 ug/dl	Continue present dose if no clinical signs for HAC If patient clinical for HAC, increase the dose by 10 mg or 25% and recheck ACTH stim 10-14 days later

Figure 6: The post-ACTH stim cortisol concentration and the patient’s recent clinical history and PE is used to guide dose adjustments.

stimulation test should be performed 10 – 14 days later. The resolution or, at least, control of clinical signs of HAC is the goal of therapy. Ensure the owner reports improvement.

COMPLIANCE

When treated with trilostane, median or mean survival times ranged from 662-930 days for PDH and 353 days for ADH.^{11,12,13,14} The most recent study to look at this was published in 2017. In this study, 52.2% of dogs treated with trilostane were still alive at 2 years post-diagnosis compared to just 8.5% of untreated dogs. Furthermore, the publication found there was no significant difference in the number of visits to the hospital or the total cost of treatments between the two groups. The investigators also found a higher risk of death in untreated dogs.²²

Occasionally, the post-ACTH stimulation cortisol result is above 9.1 µg/dL, but the dog is clinically doing well. In these cases, do not increase the dose to chase the number – the goal is resolution and/or control of clinical signs, not an absolute number on blood work.

Clinical improvement should be evident within the first two weeks of starting VETORYL Capsules. Owners should notice the dog is drinking and urinating less, and is less ravenous. Excessive panting and lethargy should be reduced (usually a 40 – 50% improvement of these common clinical signs will occur in the first two weeks). The two clinical signs that take longer to improve are abdominal girth (3-4 months for improvement) and alopecia (hair regrowth can take up to 6-9 months). A 6-month clinical efficacy trial in 60 dogs had no more than 15% of dogs exhibiting any of the clinical signs associated with HAC.⁹ Do not expect ALKP to return to normal. Most dogs will have some level of persistent hepatic vacuolar changes driven by cortisol. Monitoring ALT activity is a better indicator of hepatocellular injury, and modest increases are much more important. As these are usually older patients, consider ultrasonography of the abdomen in patients where hepatic enzymes are of concern. Rule out liver masses and

gallbladder mucoceles with ultrasound. Hypercortisolism is a predisposing factor for the development of gallbladder mucoceles, and dogs with HAC are 29 times more likely to develop one than dogs who do not have HAC.¹⁶

It should be noted that if PU/PD does not improve with control of cortisol levels, remember to rule out an urinary tract infection (UTI).

Patients with macroadenomas rarely have neurological signs at the time of presentation, but can develop them during the initial treatment of PDH with either trilostane or mitotane. Clinical signs are likely due to the removal of the negative feedback inhibition of cortisol on the pituitary and hypothalamus. Corticosteroids are often used to shrink the size of brain tumors and the removal of the endogenous cortisol can contribute to swelling or enlargement of the tumor.

Continued elevation of cortisol levels on an ACTH stimulation can be due to many causes. Timing of VETORYL Capsule administration can affect the test. The ACTH stimulation test needs to be performed during VETORYL Capsules' peak effect. Absorption of VETORYL Capsules is greatly enhanced by food; if the dog was fasted the morning of the ACTH stimulation test, cortisol levels will be affected. In addition, consider if the client is actually giving the medication consistently and following the administration instructions.

Once client factors have been ruled out, ensure the ACTH stimulation test itself is being performed appropriately. Many internists discourage the use of compounded ACTH gels, as these gels have inconsistent activity and often lead to confusing data.

Cosyntropin can be frozen into 50 µg aliquots in plastic syringes and placed in a deep freezer without an auto-defrost mode. Do not store for longer than 4 months. If the cosyntropin is stored in glass vials, or is allowed to defrost during storage, its potency can be variable.¹⁷ Finally, compounded trilostane should be used

with caution, as it may jeopardize the management of dogs with HAC and potentially impact patient safety. A 2012 study evaluated 96 batches of compounded trilostane for a variety of characteristics including percent label claim and consistency of dissolution (see Figure 7 below).

Compounding trilostane could result in dogs being under- or over-dosed, and some batches may not even be absorbed by the patient.¹⁸ If compounding is necessary for an individual patient, it is generally recommended to have the active ingredient of VETORYL Capsules compounded into another size vs. compounding bulk trilostane with an unknown origin and particle size.

On average, 4 out of 5 patients can be managed with once-daily VETORYL Capsule therapy. There are roughly 20% of patients who will need twice-daily therapy. Patients with persistent HAC clinical signs, either throughout the day or only in evening breakthroughs with



Figure 8: Same dog from Figures 3 and 4 after nine months of daily VETORYL therapy.

post-ACTH stimulation cortisol levels within the target zone (1.45 – 9.1 µg/dL) may benefit from increasing the dosing interval from once daily to twice daily. This will usually resolve the clinical signs.

VETORYL CAPSULES PRECAUTIONS/SIDE EFFECTS

When cortisol levels are normalized, underlying corticosteroid-responsive diseases may be unmasked. For example, the clinical signs of osteoarthritis and allergic skin disease may become more apparent to the owner.

ACE-inhibitors should be used with caution in patients who are taking VETORYL Capsules, as they inhibit the signal to produce aldosterone and could result in hyperkalemia. Spironolactone, a potassium-sparing diuretic, competitively inhibits aldosterone receptors and is contraindicated in patients taking VETORYL Capsules as hyperkalemia is likely to occur.⁹

Adrenal necrosis has been reported in patients receiving VETORYL Capsules. It is a rare side effect of trilostane and was seen in < 2% of dogs in the clinical trials and in far fewer since launch. Remember, mitotane is a cytolytic drug, and its mode of action is to irreversibly destroy the adrenal cortex. There are published references supporting the adrenal necrosis seen in patients taking VETORYL® Capsules is a result of elevated ACTH levels overstimulating the adrenal cells, not trilostane.¹⁹

8 Pharmacies; 12 orders per; 96 capsules/pharmacy	VETORYL Capsules	Compounded Trilostane
FDA approved	Yes	No
Consistent Dissolution	Exceeded Acceptance	20% Did not meet acceptance
% Label Claim of Active	96.1-99.6%	39-152.6%
Technical Support	Yes	No
Liability to the DVM?	No	Yes

Figure 7: Comparison of Compounded Trilostane to VETORYL Capsules. Cook, et.al¹⁸

Update on Managing Canine Hyperadrenocorticism

KEY POINTS

- **Hyperadrenocorticism is a clinical diagnosis.**
Do not treat if the patient is asymptomatic.
 - Remember, your best monitoring tool is improvement and/or control of clinical signs; if the patient is asymptomatic, then it is difficult to monitor therapy appropriately.
- **When using VETORYL Capsules (trilostane), start at the low end of the dose range.**
 - Round down when choosing a capsule size.
 - Majority of patients will do well with once-daily dosing
 - Always give VETORYL Capsules with food.
- **Early monitoring, 10 – 14 days after starting VETORYL Capsules, can help identify patients who are becoming over-suppressed.**
 - Early signs include lethargy, weakness, anorexia, vomiting, and diarrhea.
 - If an owner sees these clinical signs, they should stop the medication ASAP.
 - Evaluation includes electrolytes and an ACTH stimulation test.
- **Typically, dose increases are not made until the 30 day mark.**
Dose changes are made based on clinical signs, electrolytes, and ACTH stimulation results.
- **Beware of potential need for changes in dose requirements, even when a patient has been well-managed for a long time.**
- **Continue monitoring patients on regular intervals to ensure patients continue to do well.**
- **Client communication and compliance is key to treatment success.**
All members of your veterinary team should work together to empathize, educate, engage, and empower the client.

Written, Edited, and Presented by Dechra Veterinary Services Team



Dechra Veterinary Products Support

- Please contact **Dechra Veterinary Technical Services at (866) 933-2472** if you have any questions regarding VETORYL Capsules or to request a medical consultation for your Cushingoid patient.
- For more information about VETORYL Capsules, see the attached package insert. Additional resources are available at www.dechra-us.com.
- To report an adverse reaction, or to obtain a copy of the SDS for VETORYL Capsules, contact **Dechra Veterinary Products at (866)-933-2472 or support@dechra.com**.
- For additional information about adverse drug experience reporting for animal drugs, contact **FDA at 1-888-FDA-VETS or www.fda.gov/AnimalVeterinary/SafetyHealth**.

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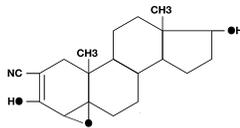
VETORYL® CAPSULES

(trilostane)

Adrenocortical suppressant for oral use in dogs only.

CAUTION: Federal (USA) law restricts this drug to use by or on the order of a licensed veterinarian.

DESCRIPTION: VETORYL Capsules are available in 5 sizes (5, 10, 30, 60 and 120 mg) for oral administration based on body weight. Trilostane (4 α ,5 α -epoxy-17 β -hydroxy-3-oxoandrostane-2 α -carbonitrile) is an orally active synthetic steroid analogue that selectively inhibits 3 β -hydroxysteroid dehydrogenase in the adrenal cortex, thereby prohibiting the conversion of pregnenolone to progesterone. This inhibition blocks production of glucocorticoids and to a lesser extent, mineralocorticoids and sex hormones while steroid precursor levels increase. The structural formula is:



INDICATIONS: VETORYL Capsules are indicated for the treatment of pituitary-dependent hyperadrenocorticism in dogs. VETORYL Capsules are indicated for the treatment of hyperadrenocorticism due to adrenocortical tumor in dogs.

DOSAGE AND ADMINISTRATION: Always provide the Client Information Sheet with prescription (see **INFORMATION FOR DOG OWNERS**).

1. Starting dose. The starting dose for the treatment of hyperadrenocorticism in dogs is 1-3 mg/lb (2.2-6.7 mg/kg) once a day. Start with the lowest possible dose based on body weight and available combinations of capsule sizes. VETORYL Capsules should be administered with food.

2. Action at 10-14 day evaluation (Table 1). After approximately 10-14 days at this dose, re-examine the dog and conduct a 4-6 hour post-dosing ACTH stimulation test and serum biochemical tests (with particular attention to electrolytes, and renal and hepatic function). If physical examination is acceptable, take action according to Table 1.

Owners should be instructed to stop therapy and contact their veterinarian immediately in the event of adverse reactions such as vomiting, diarrhea, lethargy, poor/reduced appetite, weakness, collapse or any other unusual developments. If these clinical signs are observed, conduct an ACTH stimulation test and serum biochemical tests (with particular attention to electrolytes, and renal and hepatic function).

Table 1: Action at 10-14 day evaluation

Post-ACTH serum cortisol		
$\mu\text{g/dL}$	nmol/L	Action
< 1.45	< 40	Stop treatment. Re-start at a decreased dose
1.45 to 5.4	40 to 150	Continue on same dose
>5.4 to 9.1	> 150 to 250	EITHER: Continue on current dose if clinical signs are well controlled OR: Increase dose if clinical signs of hyperadrenocorticism are still evident*
> 9.1	> 250	Increase initial dose

*Combinations of capsule sizes should be used to slowly increase the once daily dose.

3. Individual dose adjustments and close monitoring are essential. Re-examine and conduct an ACTH stimulation test and serum biochemical tests (with particular attention to electrolytes, and renal and hepatic function) 10-14 days after every dose alteration. Care must be taken during dose increases to monitor the dog's clinical signs.

Once daily administration is recommended. However, if clinical signs are not controlled for the full day, twice daily dosing may be needed. To switch from a once daily dose to a twice daily dose, the total daily dose should be divided into 2 portions given 12 hours apart. It is not necessary for the portions to be equal. If applicable, the larger dose should be administered in the morning and the smaller dose in the evening. For example, a dog receiving 90 mg would receive 60 mg in the morning, and 30 mg in evening.

4. Long term monitoring. Once an optimum dose of VETORYL Capsules has been reached, re-examine the dog at 30 days, 90 days and every 3 months thereafter. At a minimum, this monitoring should include: • A thorough history and physical examination.

• An ACTH stimulation test (conducted 4-6 hours after VETORYL Capsule administration) - a post-ACTH stimulation test resulting in a cortisol of < 1.45 $\mu\text{g/dL}$ (< 40 nmol/L), with or without electrolyte abnormalities, may precede the development of clinical signs of hypoadrenocorticism.

• Serum biochemical tests (with particular attention to electrolytes, and renal and hepatic function). Good control is indicated by favorable clinical signs as well as post-ACTH serum cortisol of 1.45-9.1 $\mu\text{g/dL}$ (40-250 nmol/L).

If the ACTH stimulation test is < 1.45 $\mu\text{g/dL}$ (< 40 nmol/L) and/or if electrolyte imbalances characteristic of hypoadrenocorticism (hyperkalemia and hyponatremia) are found, VETORYL Capsules should be temporarily discontinued until recurrence of clinical signs consistent with hyperadrenocorticism and ACTH stimulation test results return to normal (1.45-9.1 $\mu\text{g/dL}$ or 40-250 nmol/L). VETORYL Capsules may then be re-introduced at a lower dose.

CONTRAINDICATIONS: The use of VETORYL Capsules is contraindicated in dogs that have demonstrated hypersensitivity to trilostane. Do not use VETORYL Capsules in animals with primary hepatic disease or renal insufficiency (See **WARNINGS** and **PRECAUTIONS**). Do not use in pregnant dogs. Studies conducted with trilostane in laboratory animals have shown teratogenic effects and early pregnancy loss.

WARNINGS: Hypoadrenocorticism can develop at any dose of VETORYL Capsules. In some cases, it may take months for adrenal function to return and some dogs never regain adequate adrenal function.

All dogs should undergo a thorough history and physical examination before initiation of therapy with VETORYL Capsules. Other conditions, such as primary hepatic and/or renal disease should be considered when the patient is exhibiting signs of illness in addition to signs of hyperadrenocorticism (e.g. vomiting, diarrhea, poor/reduced appetite, weight loss, and lethargy). Appropriate laboratory tests to establish hematological and serum biochemical baseline data prior to, and periodically during, administration of VETORYL Capsules should be considered.

Owners should be advised to discontinue therapy immediately and contact their veterinarian if signs of potential drug toxicity are observed (see **INFORMATION FOR DOG OWNERS, DOSAGE AND ADMINISTRATION, PRECAUTIONS, ADVERSE REACTIONS, ANIMAL SAFETY AND POST-APPROVAL EXPERIENCE**).

In case of overdosage, symptomatic treatment of hypoadrenocorticism with corticosteroids, mineralocorticoids and intravenous fluids may be required.

Angiotensin converting enzyme (ACE) inhibitors should be used with caution with VETORYL Capsules, as both drugs have aldosterone-lowering effects which may be additive, impairing the patient's ability to maintain normal electrolytes, blood volume and renal perfusion. Potassium sparing diuretics (e.g. spironolactone) should not be used with VETORYL Capsules as both drugs have the potential to inhibit aldosterone, increasing the likelihood of hyperkalemia.

HUMAN WARNINGS: Keep out of reach of children. Not for human use.

Wash hands after use. Do not empty capsule contents and do not attempt to divide the capsules. Do not handle the capsules if pregnant or if trying to conceive. Trilostane is associated with teratogenic effects and early pregnancy loss in laboratory animals. In the event of accidental ingestion/overdose, seek medical advice immediately and take the labeled container with you.

PRECAUTIONS: Mitotane ($\text{o,p}'$ -DDD) treatment will reduce adrenal function. Experience in foreign markets suggests that when mitotane therapy is stopped, an interval of at least one month should elapse before the introduction of VETORYL Capsules. It is important to wait for both the recurrence of clinical signs consistent with hyperadrenocorticism, and a post-ACTH cortisol level of > 9.1 $\mu\text{g/dL}$ (> 250 nmol/L) before treatment with VETORYL Capsules is initiated. Close monitoring of adrenal function is advised, as dogs previously treated with mitotane may be more responsive to the effects of VETORYL Capsules.

The use of VETORYL Capsules will not affect the adrenal tumor itself. Adrenalectomy should be considered as an option for cases that are good surgical candidates. The safe use of this drug has not been evaluated in lactating dogs and males intended for breeding.

ADVERSE REACTIONS: The most common adverse reactions reported are poor/reduced appetite, vomiting, lethargy/dullness, diarrhea, and weakness. Occasionally, more serious reactions, including severe depression, hemorrhagic diarrhea, collapse, hypoadrenocortical crisis or adrenal necrosis/rupture may occur, and may result in death.

In a US field study with 107 dogs, adrenal necrosis/rupture (two dogs) and hypoadrenocorticism (two dogs) were the most severe adverse reactions in the study. One dog died suddenly of adrenal necrosis, approximately one week after starting trilostane therapy. One dog developed an adrenal rupture, believed to be secondary to adrenal necrosis, approximately six weeks after starting trilostane therapy. This dog responded to trilostane discontinuation and supportive care.

Two dogs developed hypoadrenocorticism during the study. These two dogs had clinical signs consistent with hypoadrenocorticism (lethargy, anorexia, collapse) and post-ACTH cortisol levels \leq 0.3 $\mu\text{g/dL}$. Both dogs responded to trilostane discontinuation and supportive care, and one dog required continued treatment for hypoadrenocorticism (glucocorticoids and mineralocorticoids) after the acute presentation.

Additional adverse reactions were observed in 93 dogs. The most common of these included diarrhea (31 dogs), lethargy (30 dogs), inappetence/anorexia (27 dogs), vomiting (28 dogs), musculoskeletal signs (lameness, worsening of degenerative joint disease) (25 dogs), urinary tract infection (UTI)/hematuria (17 dogs), shaking/shivering (10 dogs), otitis externa (8 dogs), respiratory signs (coughing, congestion) (7 dogs), and skin/coat abnormality (seborrhea, alopecia) (8 dogs).

Five dogs died or were euthanized during the study (one dog secondary to adrenal necrosis, discussed above, two dogs due to progression of pre-existing congestive heart failure, one dog due to progressive central nervous system signs, and one dog due to cognitive decline leading to inappropriate elimination). In addition to the two dogs with adrenal necrosis/rupture and the two dogs with hypoadrenocorticism, an additional four dogs were removed from the study as a result of possible trilostane-related adverse reactions, including collapse, lethargy, inappetence, and trembling.

Complete blood counts conducted pre- and post-treatment revealed a statistically significant ($p < 0.005$) reduction in red cell variables (HCT, HGB, and RBC), but the mean values remained within the normal range. Additionally, approximately 10% of the dogs had elevated BUN values (\geq 40 mg/dL) in the absence of concurrent creatinine elevations. In general, these dogs were clinically normal at the time of the elevated BUN.

In a long term follow-up study of dogs in the US effectiveness study, the adverse reactions were similar to the short term study. Vomiting, diarrhea and general gastrointestinal signs were most commonly observed. Lethargy, inappetence/anorexia, heart murmur or cardiopulmonary signs, inappropriate urination/incontinence, urinary tract infections or genitourinary disease, and neurological signs were reported. Included in the US follow-up study were 14 deaths, three of which were possibly related to trilostane. Eleven dogs died or were euthanized during the study for a variety of conditions considered to be unrelated to or to have an unknown relationship with administration of trilostane.

In two UK field studies with 75 dogs, the most common adverse reactions seen were vomiting, lethargy, diarrhea/loose stools, and anorexia. Other adverse reactions included: nocturia, corneal ulcer, cough, persistent estrus, vaginal discharge and vulvar swelling in a spayed female, hypoadrenocorticism, electrolyte imbalance (elevated potassium with or without decreased sodium), collapse and seizure, shaking, muscle tremors, constipation, scratching, weight gain, and weight loss. One dog died of congestive heart failure and another died of pulmonary thromboembolism. Three dogs were euthanized during the study. Two dogs had renal failure and another had worsening arthritis and deterioration of appetite.

In a long term follow-up of dogs included in the UK field studies, the following adverse reactions were seen: hypoadrenocortical episode (including syncope, tremor, weakness, and vomiting), hypoadrenocortical crisis or renal failure (including azotemia, vomiting, dehydration, and collapse), chronic intermittent vaginal discharge, hemorrhagic diarrhea, occasional vomiting, and distal limb edema. Signs of hypoadrenocorticism were usually reversible after withdrawal of the drug, but may be permanent. One dog discontinued VETORYL Capsules and continued to have hypoadrenocorticism when evaluated a year later. Included in the follow-up were reports of deaths, at least 5 of which were possibly related to use of VETORYL Capsules. These included dogs that died or were euthanized because of renal failure, hypoadrenocortical crisis, hemorrhagic diarrhea, and hemorrhagic gastroenteritis.

Foreign Market Experience: The following events were reported voluntarily during post-approval use of VETORYL Capsules in foreign markets. The most serious adverse events were death, adrenal necrosis, hypoadrenocorticism (electrolyte alterations, weakness, collapse, anorexia, lethargy, vomiting, diarrhea, and azotemia), and corticosteroid withdrawal syndrome (weakness, lethargy, anorexia, and weight loss). Additional adverse events included: renal failure, diabetes mellitus, pancreatitis, autoimmune hemolytic anemia, vomiting, diarrhea, anorexia, skin reactions (rash, erythematous skin eruptions), hind limb paresis, seizures, neurological signs from growth of macroadenomas, oral ulceration, and muscle tremors.

POST-APPROVAL EXPERIENCE: As of June 2013, the following adverse events are based on post-approval adverse drug experience reporting. Not all adverse reactions are reported to FDA CVM. It is not always possible to reliably estimate the adverse event frequency or establish a causal relationship to product exposure using this data. The following adverse events are listed in decreasing order of reporting frequency: anorexia, lethargy/depression, vomiting, diarrhea, elevated liver enzymes, elevated potassium with or without decreased sodium, elevated BUN, decreased Na/K ratio, hypoadrenocorticism, weakness, elevated creatinine, shaking, renal insufficiency. In some cases, death has been reported as an outcome of the adverse events listed above.

For a cumulative listing of adverse reactions for trilostane reported to the CVM see: <http://www.fda.gov/ADREports>

This listing includes Adverse Events reported to CVM for products, such as VETORYL Capsules, that contain the active ingredient trilostane. Listings by active ingredient may represent more than one brand name.

To report suspected adverse events and/or obtain a copy of the MSDS or for technical assistance, call Dechra Veterinary Products at (866) 933-2472.

For additional information about adverse drug experience reporting for animal drugs, contact FDA at 1-888-FDA-VETS or online at: <http://www.fda.gov/AnimalVeterinary/SafetyHealth>

INFORMATION FOR DOG OWNERS: Owners should be aware that the most common adverse reactions may include: an unexpected decrease in appetite, vomiting, diarrhea, and azotemia, or lethargy and should receive the Client Information Sheet with the prescription. Owners should be informed that control of hyperadrenocorticism should result in resolution of polyphagia, polyuria and polydipsia. **Serious adverse reactions associated with this drug can occur without warning and in some cases result in death (see ADVERSE REACTIONS and POST-APPROVAL EXPERIENCE).**

Owners should be advised to discontinue VETORYL Capsules and contact their veterinarian immediately if signs of intolerance such as vomiting, diarrhea, lethargy, poor/reduced appetite, weakness, or collapse are observed. Owners should be advised of the importance of periodic follow-up for all dogs during administration of VETORYL Capsules.

CLINICAL PHARMACOLOGY: Trilostane absorption is enhanced by administration with food. In healthy dogs, maximal plasma levels of trilostane occur within 1.5 hours, returning to baseline levels within twelve hours, although large inter-dog variation occurs. There is no accumulation of trilostane or its metabolites over time.

EFFECTIVENESS: Eighty-three dogs with hyperadrenocorticism were enrolled in a multi-center US field study. Additionally, 30 dogs with hyperadrenocorticism were enrolled in two UK field studies. Results from these studies demonstrated that treatment with VETORYL Capsules resulted in an improvement in clinical signs (decreased thirst, decreased frequency of urination, decreased panting, and improvement of appetite and activity). Improvement in post-ACTH cortisol levels occurred in most cases within 14 days of starting VETORYL Capsules therapy.

In these three studies, there were a total of 10 dogs diagnosed with hyperadrenocorticism due to an adrenal tumor or due to concurrent pituitary and adrenal tumors. Evaluation of these cases failed to demonstrate a difference in clinical, endocrine, or biochemical response when compared to cases of pituitary-dependent hyperadrenocorticism.

ANIMAL SAFETY: In a laboratory study, VETORYL Capsules were administered to 8 healthy 6 month old Beagles per group at 0X (empty capsules), 1X, 3X, and 5X the maximum starting dose of 6.7 mg/kg twice daily for 90 days. Three animals in the 3X group (receiving 20.1 mg/kg twice daily) and five animals in the 5X group (receiving 33.5 mg/kg twice daily) died between Days 23 and 46. They showed one or more of the following clinical signs: decreased appetite, decreased activity, weight loss, dehydration, soft stool, slight muscle tremors, diarrhea, lateral recumbency, and staggering gait. Bloodwork showed hyponatremia, hyperkalemia, and azotemia, consistent with hypoadrenocortical crisis. Post-mortem findings included epithelial necrosis or cystic dilation of duodenal mucosal crypts, gastric mucosal or thymic hemorrhage, atrial thrombosis, pyelitis and cystitis, and inflammation of the lungs.

ACTH stimulated cortisol release was reduced in all dogs treated with VETORYL Capsules. The dogs in the 3X and 5X groups had decreased activity. The 5X dogs had less weight gain than the other groups. The 3X and 5X dogs had lower sodium, albumin, total protein, and cholesterol compared to the control dogs. The 5X dogs had lower mean corpuscular volume than the controls. There was a dose dependent increase in amylose. Post-mortem findings included dose dependent adrenal cortical hypertrophy.

STORAGE INFORMATION: Store at controlled room temperature 25°C (77°F) with excursions between 15°-30°C (59°-86°F) permitted.

HOW SUPPLIED: VETORYL Capsules are available in 5, 10, 30, 60 and 120 mg strengths, packaged in aluminum foil blister cards of 10 capsules, with 3 cards per carton.

VETORYL Capsules 5 mg	NDC 17033-105-30
VETORYL Capsules 10 mg	NDC 17033-110-30
VETORYL Capsules 30 mg	NDC 17033-130-30
VETORYL Capsules 60 mg	NDC 17033-160-30
VETORYL Capsules 120 mg	NDC 17033-112-30

TAKE TIME  **OBSERVE LABEL DIRECTIONS**

NADA 141-291, Approved by FDA.

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