Review Article

BASJVETRES

BASRAH JOURNAL OF VETERINARY RESEARCH, 2024, 23(4):242-257.
https://bjvr.uobasrah.edu.iq/

Endocrinopathies in Small Animals: A Comprehensive Review

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DOI: https://doi.org/10.23975/bjvr.2024.149732.1087

Received: 18 May 2024 Accepted: 22 July 2024.

Abstract

Endocrine disorders are prevalent in dogs and cats, including a substantial proportion of chronic illnesses in pet animal patients. Canines and felines with endocrinopathies are susceptible to many severe consequences that can impact their overall well-being. Many endocrinopathies, including diabetes mellitus, Cushing disease, Addison disease, hypothyroidism, and hyperthyroidism, have many complications. Gaining a better understanding of these illnesses can facilitate early detection of the disease condition and enable the implementation of fast steps, slow their progression, or provide suitable treatment. Providing a detailed account of commonly occurring endocrinopathies enables healthcare professionals in educational settings to be better equipped, as there is a shortage of clinical veterinarians specializing in this field. Further studies are necessary to better understand these conditions in dogs and cats. The present article provides an overview of endocrine illnesses in companion animals commonly encountered in pet animal practice. Moreover, it focuses on the current diagnostic criteria and suggests treatment options for these conditions.

Keyword: Feline, Canine, Endocrine disorders, A review.

Introduction

Endocrine disorders are common diseases in pet animals (1).The presence of various endocrine abnormalities in veterinary patients. However, it has not been extensively published (2). Endocrine disorders arise from disturbances in the equilibrium of hormone levels and metabolism. Hormone abnormalities can impact animal health in several ways. While specifics endocrine issues may not pose an immediate threat to life, a significant number of them might result in chronic illness and even fatality if left undiagnosed and untreated. Diseases can arise due to either intrinsic dysfunction of an endocrine gland or impaired regulation of that organ, including dysfunction in the pituitary gland, which can adversely affect the adrenal glands). Endocrine disorders can result from excessive hormone production (hyper-diseases) or insufficient hormone production (hypo-diseases). The manifestations of endocrine illnesses are varied, and the observations made during the medical history and physical examination reflect this variability. The detailed explanation of commonly occurring endocrinopathies enables health professionals in educational settings to be better equipped, as there is a scarcity of clinical veterinarians specializing in this field (3). A compilation of prevalent presentations is presented in (Table 1). Animals can experience multiple endocrine illnesses, like autoimmune polyendocrine syndromes or multiple endocrine neoplasia. However, most abnormalities typically impact a single hormone system. A thorough analysis of endocrine physiology is crucial for comprehending the fundamental causes of endocrine issues and identifying the reasoning and constraints of endocrine function testing. The widespread availability of highly precise methods for monitoring hormone levels and advanced diagnostic imaging techniques has significantly advanced our understanding of endocrine disorders. (4).

Table 1: Frequent manifestations of endocrine disorders.

– Polyuria–polydipsia
– Weight gain / obesity
– Reduced weight
– growth retardation
– Alopecia symmetrica
– Intermittent debilitation and sudden loss of consciousness
– Hypertension

Common endocrine diseases

1-Hyperadrenocorticism

Hypercortisolism (HC), or Cushing syndrome, is a condition characterized by excessive and pathological production of cortisol. It often affects dogs in the middle to older age range. HC affects senior cats infrequently. The average age of diagnosis for HC is ten years. Clinical manifestations of hypercortisolism can arise not only from pituitary-dependent and adrenal-dependent causes but also from tumors in the adrenal glands that produce sex steroids (5). A high level of glucocorticoids leads to a mixture of physiological and metabolic changes that substantially impact the animal's overall welfare. HC can result from either excessive secretion of adrenocorticotropic hormone (ACTH) by a functional pituitary tumor (known as pituitary-dependent hyperadrenocorticism or PDH) or from a primary adrenal tumor (AT). In canines, HC caused by abnormalities other than food-dependent hypercortisolemia or ectopic secretion of ACTH has been reported recently (6). However, these appear to be uncommon conditions.

Table 2: A systematic diagnostic approach to HC. (7).

A systematic diagnostic approach to HC.
Step 1: Analyse regular Results of the laboratory for indications of HC - urine analysis SG < 1.020 Proteinuria - Chemistry results Elevated alkaline phosphatase (ALP) levels with Cholesterolemia +/- hyperphosphatemia +/- high blood suger level (mild; <150 mg/dL) +/- Decreased blood urea nitrogen levels +/- increased ALT or GGT - CBC neutrophilia, lymphopenia, monocytosis, and eosinopenia increased hematocrit +/- Thrombocythemia
Step 2: diagnostics for Hyperadrenocorticism - low dose dexamethasone suppression test LDDST - ACTH stimulation test - The urine cortisol-to-creatinine ratio has limited specificity, meaning that a positive result alone is not sufficient evidence to confirm this diagnosis.
Step 3: distinguish PDH and AT (only if adrenalectomy is being considered). - Sonography of the abdomen - quantification of endogenous ACTH - HDDST (poor accuracy; unable to distinguish between PDH and AT when suppression is not achieved))

Due to its high sensitivity, (LDDST) is undoubtedly HC's best initial screening test. However, when applying the same method used for dogs (administering 0.01 mg/kg intravenously and testing blood cortisol levels at 0, 4, and 8 hours), around 10-20% of healthy feline participants will not show any suppression. To improve the precision of the test, the LDDST protocol in cats involves giving a larger dose of dexamethasone (0.1 mg/kg IV), which is ten times the usual amount. Blood cortisol levels are then measured at 0, 4, and 8 hours. This approach aims to decrease the levels of cortisol in the blood of healthy cats after 4 and 8 hours, bringing them down to approximately <40 nmol/1 (or a similar reference period, as determined by the laboratory) (Figure 1) (5).

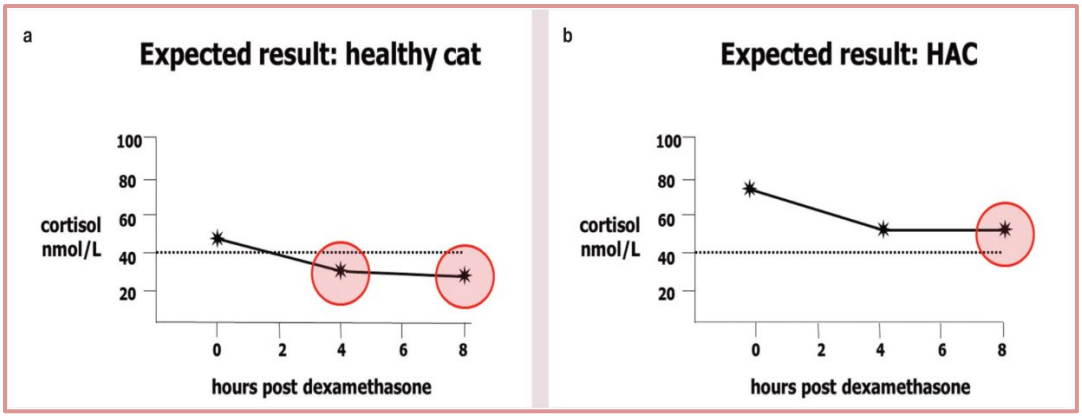

Figure 1: Anticipated outcomes of LDDST using 0.1 mg/kg of dexamethasone administered intravenously in a feline in good health (a) and a feline with HC(b).

Abdominal ultrasonography can easily distinguish between PHD and adrenal tumor (AT), although its accuracy depends on the operator's skill and the machine's quality. The typical width of the adrenal gland at its lower end is 3 to 5 mm. However, it is not uncommon to observe adrenal glands measuring 7 mm in size in large dogs suffering from nonadrenal diseases. In a dog with a positive result on a confirmatory test for HAC, bilateral and symmetric enlargement of the adrenal glands implies PDH. A solitary tumor in a single gland suggests the probability of an adrenal tumor. It is expected to see contralateral atrophy, with a size reduction of less than 4 to 5 mm. Dogs can develop pheochromocytoma or adrenal tumors alongside PDH. Abdominal radiography serves as an alternative to ultrasonography. Approximately 50% of ATs undergo calcification and are visible on a standard lateral abdominal radiograph. Multiple reference laboratories offer highly sensitive assays for measuring endogenous ACTH levels, enabling accurate differentiation between the two subtypes of HC. Dogs with AT have extremely low levels of detectable hormones, whereas dogs with PDH have normal or elevated hormone levels (7).

Various therapy methods have been employed to address cats and dogs with HC, including medicinal intervention, adrenalectomy, transsphenoidal hypophysectomy, and pituitary gland irradiation. Only the surgical procedures of adrenalectomy or transsphenoidal hypophysectomy can provide a cure. Unilateral adrenalectomy for ADH or bilateral adrenalectomy for PDH, while potentially curative, carries a relatively significant risk of complications due to impaired wound healing, weakened immune system, and fragile skin. Nine cats with pituitary adenomas have undergone microsurgical transsphenoidal hypophysectomy for PDH, and their complications seen oronasal fistula, soft palate dehiscence, temporary reduction in tear production, and a relapse of HC caused by pituitary remains (5).

2. Hypodrenocorticism

Canine spontaneous hypoadrenocorticism (HA) or Addison disease is an infrequent disorder (0.1%) in canines. (8). The condition is prevalent among female caninesaged2 months to 14 years, typically affecting young to middle-aged dogs. The average age at which the disease starts is 4 years. (9). Is a potentially life-threatening endocrine disease characterized by deficiencies in cortisol and aldosterone produced by the adrenal cortex (10). There are two forms of the disease: typical, in which there is a deficiency of glucocorticoids, and mineralocorticoids, atypical, which is accompanied by a deficiency of only glucocorticoids. These hormones are necessary for the body to maintain homeostasis and are extremely important for the normal functioning of the body. HA differs from other endocrine disorders by its intermittent nature. Certain breeds, such as Standard Poodles, Nova Scotia Duck Tolling Retrievers, Portuguese Water Dogs, and Bearded Collies, are found to be overrepresented. Inheritance has been scientifically established in these breeds. Additional breeds frequently affected by HA without confirmed hereditary links include crossbreed dogs, non-Standard Poodle varieties, Golden Retrievers, Cairn Terriers, Rottweiler Great Danes, and West Highland White Terriers. (8). Approximately 25-43% of dogs have symptoms of the disease periodically, appear, then disappear, and after a while appear again (11). It is caused primarily by primary immune-mediated adrenal cortex damage, which leads to insufficient hormone secretion in the adrenal cortex, causing a chain reaction. The main symptoms of Addison's illness are anorexia, vomiting, diarrhea, dehydration, hyponatraemia, azotemia, hypochloraemia, and hyperkalemia. Patients with HA may exhibit a wide range of laboratory abnormalities associated with insufficient levels of glucocorticoid and/or mineralocorticoid hormones. These abnormalities include non-regenerative anemia, leukocytosis, low blood sugar, increased blood urea nitrogen and creatinine levels, high potassium levels, low sodium levels, high calcium levels, low cholesterol levels, high phosphorus levels, low chloride levels, and elevated liver enzymes.

The ACTH stimulation test is often regarded as the most dependable approach for diagnosing HA. This test assesses the adrenal gland's ability to secrete cortisol in response to a potent stimulation. Due to the critical nature of the Addisonian crisis, the treatment primarily aims to correct conditions such as low blood volume, low blood pressure, abnormalities in electrolyte levels, and the provision of corticosteroid and mineralocorticoid supplements. The ongoing use of corticosteroids and/or mineralocorticoids, such as desoxycorticosterone pivalate or fludrocortisone, as a supplement is necessary for stable HA.Regular monitoring of patients with HA involves ACTH stimulation testing, while some experts suggest that measuring endogenous ACTH is the most effective method for therapeutic surveillance. The prognosis for canine HA is highly favorable with consistent treatment (8).

3. Diabetes mellitus

Diabetes mellitus (DM) is a common hormonal disorder in dogs, with an estimated frequency of approximately 0.32-0.36%. (12). Dogs with clinical diabetes mellitus exhibit the depletion of pancreatic islet cells, leading to a lack of insulin and prolonged high blood sugar levels. This condition manifests in symptoms such as increased urination, excessive thirst, excessive hunger, and weight loss. The precise cause of islet cell loss is frequently uncertain and likely varies. . At the same time,there are apparent resemblances between specific types of DM in dogs and type 1 diabetes mellitus (T1DM) in humans. Genetics, age, sex, neutering status, obesity, pharmacological therapy, infection, and concomitant disease are all recognized factors linked to DM in dogs. DM is typically detected more frequently in canines in the intermediate to senior age range, those over 5 years old. Reported breed predispositions may vary among countries, however, specific breeds such as Samoyeds, miniature schnauzers, Cairn terriers, and Yorkshire terriers have been found to be more susceptible. In contrast, German Shepherd Dogs (GSD), Golden Retrievers, and Boxers exhibit a reduced susceptibility. The existing data on the association between sex and neuter status as risk factors is inconclusive, possibly due to variations in neutering programs among different countries. Dioestrus-associated diabetes is more prevalent in regions where spaying female dogs is not a standard practice. This pertains to the inhibitory impact of progesterone on insulin and the release of growth hormone from the mammary glands in dogs, which is influenced by progesterone. Several studies indicate that females have a higher risk than males,than males, and neutered males have a higher risk than intact males (12). Nevertheless, it remains uncertain if sexual activity alone is linked to DM, and certain studies have also been unable to establish a connection with neutering. However, this may be due to the restricted size of their sample populations (13). DM is a prevalent endocrine disorder in cats. Most cats with DM exhibit similarities to Type 2 DM in humans, arising from reduced b-cell function, insulin resistance, and influential environmental and genetic variables.

Nevertheless, feline DM can also arise from alternative factors, hypersomatotropism, hyperadrenocorticism, pancreatic illness, and the prescription of diabetogenic drugs. For cats, obesity is a major threat factor to develop DM. Around 80% or more of cats are affected by Type II Diabetes. Given the variations in these forms of diabetes, the treatment and management of diabetes in dogs and cats differ (14). The presence of glycosuria and persistent fasting hyperglycemia (>200 mg/dL) is the foundation for diagnosing diabetes mellitus. The normal range for fasting blood glucose in dogs and cats is often between 75 and 120 mg/dL. The Complete Blood Count often shows no abnormalities.

If pancreatitis or infection is present, one may see neutrophilic leukocytosis or the presence of toxic neutrophils. The biochemistry panel indicates elevated blood glucose levels (hyperglycemia), high cholesterol levels (hypercholesterolemia), and high triglyceride levels (hypertriglyceridemia). The urinalysis shows that the urine specific gravity is usually greater than 1.025, with the presence of glycosuria and varying levels of ketonuria. Cats frequently experience stress-induced hyperglycemia, and confirming the diagnosis may need multiple blood and urine tests. Measuring serum fructosamine can aid in differentiating between diabetes mellitus and hyperglycemia induced by stress. During instances of stress-induced hyperglycemia, fructosamine levels remain within the normal range. (15). The treatment regimen includes administration of insulin by injections, adherence to a specific diet, achieving weight loss, and sometimes taking oral hypoglycemic medications. Spaying intact females is highly recommended. Recent research has confirmed the efficacy of low carbohydrate, high protein diets for cats. Dogs should consume diets that are abundant in complex carbohydrates and have a high fibre content. Insulin therapy is necessary as the primary intervention as relying solely on diet and weight loss will not suffice to manage the condition. Most dogs require two daily injections of insulin. The preferred initial insulin options are usually Neutral Protamine Hagedorn (NPH) or lente, which are taken twice daily at a dosage of 0.5 U/kg, as indicated in (Table 3). Cats are initiated on high-protein meals and insulin medication, and their progress is reassessed after 5-7 days. Insulin glargine is the preferred insulin for cats who have been recently diagnosed. Long-acting basal insulin, such as glargine, is used with low-carbohydrate, high-protein diets. However, there is no apparent correlation between these insulins and high rates of diabetic remission. Cats suffering from diabetes may be prescribed oral hypoglycemic medicines, such as glipizide. The recommended daily dose of glimepiride for cats is 2 mg, while for glyburide, it is 0.625 mg. Cats can be treated for hyperglycemia using acarbose, an oral medication that inhibits α-glucosidase. The recommended dosage is 12.5-25 mg, taken two to three times daily, along with a controlled diet and/or insulin therapy. For treating DM in dogs, it is desirable to have new insulins that can be injected less frequently yet still preserve safety and effectiveness. A study demonstrates that the fusion of insulin with immunoglobulin-

fragment-crystallizable (Fc) results in an exceptionally extended plasma half-life. This is attributed to recycling the fused insulin through cells, which protects against proteolysis. This once-weekly new insulin construct controlled clinical symptoms, body weight, and glycemia maintenance in 4 out of 5 dogs (16).

Table 3: Initial dosage and dosage range for insulin products administered to canines with diabetes (17).

Insulin	Starting dose	Median dose	Dose range
NPH	0.25-0.5 U/kg	0.5 U/kg	0.2-1.0 U/kg
Lente	0.25-0.5 U/kg	0.7 U/kg	0.3-1.4U/kg
PZI	0.5 U/kg	1.0 U/kg	0.4 -1.5U/kg
Glargine	0.5 U/kg	0.6 U/kg	0.1-1.1 U/kg
Detemir	0.1-0.2 U/kg	---	0.07-0.23 U/kg

4. Hyperthyroidism

It is a disorder that impacts approximately 10% of elderly cats and is associated with increased mortality and detrimental effects on multiple organs. This illness, known as hyperthyroidism, occurs when there are abnormally high levels of triiodothyronine (T3) and/or thyroxine (T4) in the bloodstream. These raised hormone levels are caused by a malfunctioning thyroid gland. From a histological perspective, the majority of infected cats exhibit benign adenomatous hyperplasia (adenoma), while only a minority develop thyroid cancer. The average age of diagnosis is around 13 years, and it is rare for cats younger than 10 years old to be diagnosed. (18). This syndrome is regarded as atypical in canines. While there is comprehensive documentation of the clinical and pathological characteristics of the disease, the precise cause(s) remain(s) unknown. Researchers have investigated a variety of possibilities, including immunological, infectious, dietary, environmental, and genetic variables.Several studies have indicated that having a purebred lineage, especially of Siamese, Himalayan, or Burmese breeds, is linked to a reduced likelihood of developing the disease. This implies that regardless of the origin of the disease, there is a hereditary inclination for its occurrence. The characteristic symptoms of Feline Hyperthyroidism (FHT) include loss of weight, excessive appetite, increased urination, excessive thirst, increased vocalization, restlessness, increased physical activity, rapid breathing, rapid heart rate, vomiting, diarrhea, and an unkempt hair coat (19). The evaluation of hyperthyroidism typically relies on a robust clinical

suspicion. Nevertheless, the condition may occasionally be incidentally detected during routine annual health checks (20). The diagnosis of FHT IS on the existence of one or more observable indications of a medical condition or Elevated levels of thyroxine (T4) in the blood. Nevertheless, approximately 10% of hyperthyroid cats and 40% of those with mild illness exhibit serum T4 levels within the standard range. It is not advisable to rule out hyperthyroidism only based on a single, normal level of serum T4. This is particularly true for cats that exhibit typical clinical symptoms, have a detectable thyroid nodule, and have serum T4 levels in the upper half of the normal range. For these situations, the use of serum-free T4, assessed using equilibrium dialysis (fT4ED), could offer an alternative method of diagnosis. Studies indicate that as many as 20% of cats with sick euthyroid syndrome may exhibit elevated levels of fT4. Consequently, it is both suitable and dependable to interpret the two findings in conjunction. Elevated levels of blood total T4 and higher concentrations of fT4 indicate hyperthyroidism. Low serum total T4 levels and normal or elevated fT4 values typically characterize nonthyroidal disease. There are five primary approaches to controlling feline hyperthyroidism: The treatment options for thyroid disorders include oral anti-thyroid medication, following an iodine-restricted diet, radioiodine treatment, surgical removal of the thyroid gland (thyroidectomy), and the use of transdermal anti-thyroid medicine (which is not recommended by veterinarians). The most commonly employed method for treating hyperthyroidism is the regular administration of anti-thyroid medicines, either orally or through the skin. These medications can be administered over an extended period as the only form of treatment or for a brief period To ensure the patient's stability before undergoing any surgical treatment or anesthesia or in situations when quick access to radioiodine therapy is unavailable. Methimazole and carbimazole are two licensed veterinary medicines used to treat hyperthyroidism (19). Methimazole functions by obstructing the activity of thyroid peroxidase, consequently hindering thyroid hormone production. Methimazole is believed to accumulate in the thyroid glands of cats, similar to humans. The absorption of oral methimazole in healthy cats is efficient, and hyperthyroidism does not significantly affect the pharmacokinetic properties of the drug (20). Restricted iodine diets can be used to regulate thyroid hormone levels and relieve symptoms of hyperthyroidism. Adequate dietary iodine is necessary for the synthesis of thyroid hormone. The sole recognized use of ingested iodine is the creation of thyroid hormones. Based on this result, it was hypothesized that restricting the consumption of iodine in the food could regulate the production of thyroid hormones and potentially treat hyperthyroidism in cats. This option is uncomplicated and direct, necessitating solely a modification in dietary habits. Cats with renal insufficiency experience a response rate of over 82% when on the diet, which is safe. Radioactive iodine is the most effective treatment for FHT. Following injection, the thyroid gland aggressively concentrates on it, demonstrating a decay rate that spans over

eight days. The emission of both beta-particles and gamma radiation occurs. However, the beta-particles largely induce localized tissue damage, with a maximum range of two millimeters. Hence, it is anticipated that there will be no substantial harm to neighboring parathyroid tissue, atrophied thyroid tissue, or other tissues in the cervical region. It eradicates aberrant cells in all areas and achieves a cure rate above 95 percent. The treatment is uncomplicated, involving either a single injection or oral capsule, and severe adverse effects are infrequent. Minimal testing is required following effective therapy with a low likelihood of permanent hypothyroidism. One option is a permanent treatment achieved through thyroidectomy. If both glands are surgically removed, the cure rate for this condition exceeds 90 percent. However, if only one gland is removed, the cure rate ranges from 35 to 60 percent. The recovery time for disease after surgery is one to two days, and the relapse incidence is approximately five percent for bilateral procedures and 30 percent for unilateral procedures. The drawbacks of surgical thyroidectomy encompass heightened risks associated with administering general anesthesia to a feline with a damaged circulatory system, potential harm to the parathyroid gland, and the occurrence of temporary or permanent calcium imbalance. Hospitalization is necessary for the procedure, which is irreversible. Before the surgery, most hyperthyroid cats need to be stabilized with medication. The vocalization or purring of the cat may undergo alterations during the surgical procedure (21). Transdermal anti-thyroid medication refers to medications applied to the skin and developed to administer therapeutic medication concentrations directly into the bloodstream. Several studies have confirmed the effectiveness of applying methimazole through the skin for treating hyperthyroidism. The transdermal approach is associated with a reduced incidence of gastrointestinal side effects. Cats treated via this method typically require a comparable or slightly higher dosage than oral administration. The attainment of euthyroidism may require a longer duration when compared to the administration of oral anti-thyroid medication. However, the majority of treated cats reach euthyroidism within around four weeks (20).

5. Hypothyroidism

Hypothyroidism is a hormonal disorder that occurs in 0.2% to 0.8% of the canine population, mainly in middle-aged dogs. The prevalence of the disease seems to be comparable among both males and females, irrespective of their neutered or intact status (22). The risk of hypothyroidism increased in several dog breeds, as shown in Table 4. It can be either acquired or congenital. Hypothyroidism is categorized as primary when it is caused by an anomaly in the thyroid gland itself, secondary when it is caused by reduced secretion of TSH (thyroid-stimulating hormone), and tertiary when it is caused by a shortage of TRH (thyrotropin-releasing hormone). The causes of primary hypothyroidism include lymphocytic thyroiditis, idiopathic atrophy, neoplastic destruction, and other causes. Tertiary hypothyroidism and pituitary

neoplasia are both manifestations of secondary hypothyroidism (23). The majority of cases, around 95%, are attributed to lymphocytic thyroiditis or idiopathic atrophy of the thyroid gland, resulting in a reduction in the synthesis of thyroid hormones. Thyroid neoplasia, congenital hypothyroidism, and secondary and tertiary hypothyroidism make up the remaining 5% of instances of hypothyroidism (24). The disease progresses gradually, and clinical manifestations are unlikely to appear unless at least 75% of the thyroid is impacted. Due to the diverse physiological impacts of thyroid hormones on multiple organ systems, the clinical manifestations of hormone insufficiency are extensive and nonspecific. Frequently, these symptoms can be attributed to a reduced metabolic rate, characterized by tiredness, reluctance to engage in physical activity, intolerance to exercise, and weight gain despite a normal appetite level. Additional frequent observations include dermatological irregularities such as seborrhea, hair loss, baldness, predominantly affecting the sides and tail, skin darkening, and superficial skin infection (25). Detecting hypercholesterolemia and non-regenerative anemia in a blood analysis can enhance the probability of diagnosing hypothyroidism. Hypercholesterolemia is present in approximately 75% of patients. Unfortunately, hypercholesterolemia is frequently observed with several additional conditions like hyperadrenocorticism, diabetes mellitus, glomerulopathies, and liver illnesses.

Normocytic normochromic anemia is observed in 30% of dogs with hypothyroidism. However, the packed cell volume typically remains above 25%. The etiology of this anemia may be attributed to diminished erythropoietin and thyroid hormone-induced erythrocyte synthesis. In order to determine the diagnosis, it is imperative to assess the thyroid gland directly, as the clinical signs are ambiguous, and standard blood tests do not indicate any specific abnormalities. These tests should be regularly conducted on a dog who displays clinical symptoms of hypothyroidism. It is crucial to acknowledge thate diagnostic test's positive predictive value grows as the disease's prevalence rises. The likelihood of obtaining a positive confirmation result from the diagnostic test is higher when there is a strong suspicion that the patient has the illness. The veterinarian can effectively diagnose the condition by performing a thorough clinical examination of the patient, having knowledge about the benefits and drawbacks of all available tests, and recognizing the variables that can influence the test outcomes. A summary of the benefits and drawbacks of the most frequently used thyroid tests for canines is presented in **(**Table 5). The tests included total thyroxin endogeneous thyrotropine, free thyroxin, thyrotropine stimulation test, and anti-thyroglobuline antibodies (ATG) (26). Other tests incorporate Scintigraphy, which, if accessible, is an extremely valuable technique for assessing thyroid function. It is more frequently employed in assessing feline hyperthyroidism compared to canine hypothyroidism. According to a study conducted by (27), this test has been

found to be highly reliable in confirming the condition. Recently, the effectiveness of machine learning algorithms in accurately predicting and quantifying the likelihood of hypothyroidism in dogs was confirmed. (Figure 2) illustrates the results obtained from the algorithms, which utilized four models as predictors (28). The models utilized in the study are detailed in (Table 6). Treating hypothyroidism requires the long-term use of synthetic levothyroxine (L-T4). The dosages given to dogs are generally higher than those used in human therapy. The initial doses for treatment vary between 10 and 20 µg/kg, given every 12 or 24 hours, depending on the author and the exact formulation used. The highest dosage of L-thyroxine is 0.8 mg per 12 hours. The patient undergoes a reevaluation 1 to 2 months after starting medication, and the dosage is modified according to the clinical response and the results of the blood TT4 test. Regarding cats, if there is resistance to the use of levothyroxine supplements, as shown by consistently high levels of TSH in the blood, it may be beneficial to take the medication on an empty stomach. This is because food can hinder the absorption of the (29).

Conclusions

The timely identification of endocrine disorders through advanced and fast diagnostic methods, followed by appropriate management, significantly enhances pets' lifespan and overall well-being. To achieve this, veterinarians must stay updated on the latest clinical research advancements in this field. Additionally, practicing veterinarians must be knowledgeable about the potential complications associated with endocrinopathies, particularly diabetes mellitus, in order to address them early.

Conflicts of interest

The authors declare that there is no conflict of interest.

Table 4: Breed-specific distribution of hypothyroid cases in canines (N=35) (30).

Dog Breed	Number of Cases	Percentage (%)
Labrador	18	51.43
Pug	7	20.00
Dachshund	2	5.71
Samoyed	3	8.57
German Shepherd	2	5.71
Mongrel	1	02.86
Shih Tzu	1	2.86
Pitbull	1	2.86
Total	35	100

Table 5: Common thyroid test benefits and drawbacks (26).

Test	Advantages	Disadvantages
TT4	Readily available, not expensive Normal values often allow 'exclusion' of hypothyroidism	↓ with systemic disease (euthyroid sick syndrome) ↓ after administration of certain drugs A ↓ T4 alone does not allow a reliable diagnosis of hypothyroidism (low specificity)
TSH	Readily available, not expensive	1/4 of hypothyroid dogs have TSH values within the reference range (low sensitivity) Always use in combination with T4
FT4	Is less influenced by systemic disease or drug administration than TT4	The only reliable method includes equilibrium dialysis Not readily available in all countries
Anti-thyroglobulin Ab	Testing for thyroid autoimmunity	Not routinely available in all countries Does not reflect thyroid function
Scintigraphy (99mTc04-)	Reliable, considered as a gold standard	Limited availability Use of radio nuclides Sometimes need for sedation
Thyroid ultrasonography	Theoretically interesting	Very operator- and machine dependant
TSH stimulation test	Reliable, considered as a gold standard (rhTSH)	rhTSH* is expensive (less if aliquoted) 6 hours lasting test Anaphylactic reactions were described with bovine TSH (not yet with rhTSH)

***rhTSH: recombinant human TSH**

Table 6: The variables are taken into account when creating the four unique models for diagnosing hypothyroidism. (28).

Model	Variables
model1	Cholesterol (normal/increased/markedly increased), Hct (decreased/normal), creatinine (normal/increased), asthenia (yes/no), lethargy/depression (yes/no), alopecia (yes/no), obesity (yes/no), dermatopathy, breed
model2	tT4 (normal/decreased/markedly decreased), TSH (normal/increased), cholesterol (normal/increased/ markedly increased), Hct (decreased/normal), creatinine (normal/increased), asthenia (yes/no), lethargy/depression (yes/no), alopecia (yes/no), obesity (yes/no), dermatopathy (yes/no), breed
model3	Cholesterol (mg/dL), Hct (%), creatinine (mg/dL), asthenia (yes/no), lethargy/depression (yes/no), alopecia (yes/no), obesity (yes/no), dermatopathy (yes/no), breed
model4	tT4 (nmol/L), TSH (ng/mL), cholesterol (mg/dL), Hct (%), creatinine (mg/dL), asthenia (yes/no), lethargy/depression (yes/no), alopecia (yes/no), obesity (yes/no), dermatopathy (yes/no), breed

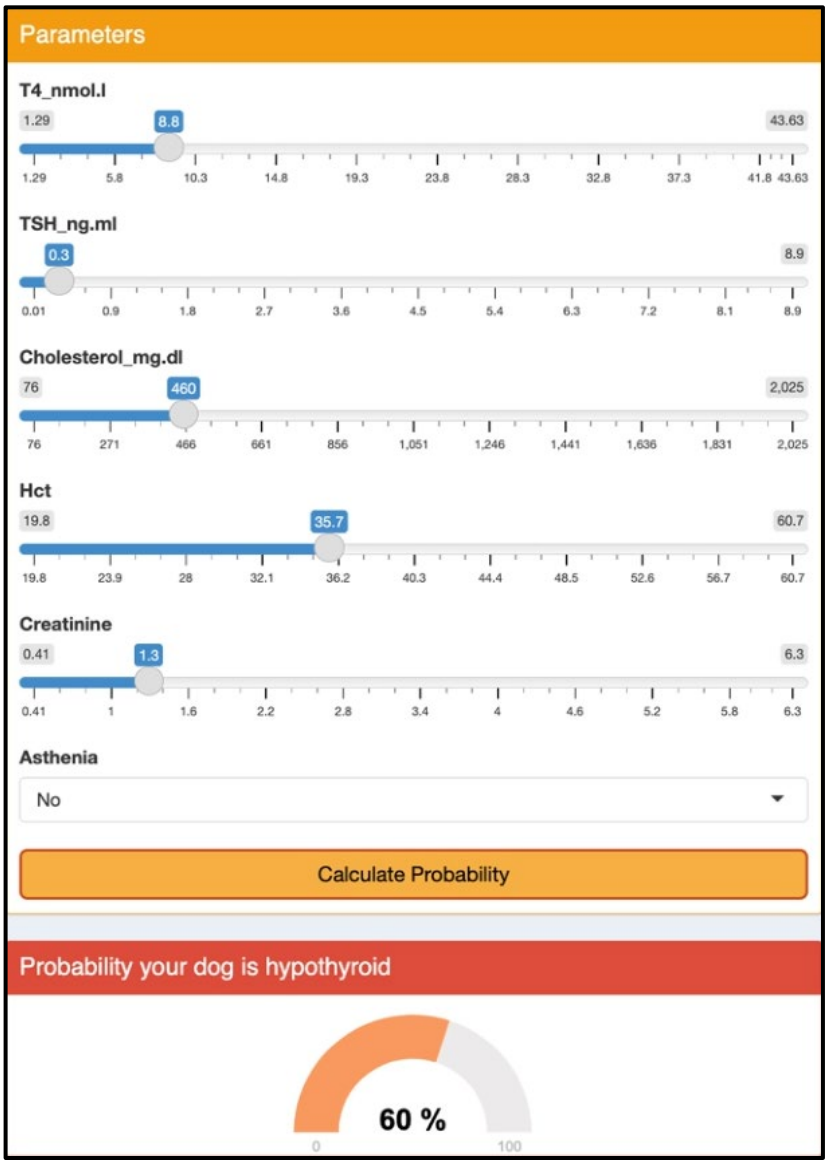

Figure 2: Model 4 graphical user interface for diagnosing hypothyroidism. The 'Calculate Probability' icon is selected after medical record numbers are entered via the menu. The algorithm provides a percentage representation of the likelihood that the dog is hypothyroid.

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اعتلالات الغدد الصم في الحيوانات المنزلية الاليفة: مراجعة شاملة

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الخلاصة

تعد اضطرابات الغدد الصم من الاضطرابات الصحية السائدة في الكلاب والقطط، بما في ذلك نسبة كبيرة من الأمراض المزمنة لدى الحيوانات المنزلية الاليفة. القطط المصابة باعتلالات الغدد الصم معرضة للعديد من العواقب الوخيمة التي يمكن أن تؤثر على صحتها بشكل عام. العديد من اعتلالات الغدد الصم، بما في ذلك داء السكري، ومرض كوشينغ، ومرض أديسون، وقصور الغدة الدرقية، وفرط نشاط الغدة الدرقية، لها العديد من المضاعفات. إن اكتساب فهم أفضل لهذه الأمراض يمكن أن يسهل الاكتشاف المبكر لحالة المرض، كما يمكن من تنفيذ خطوات سريعة لتجنب حدوثها أو إبطاء تقدمها أو تقديم العلاج. إن توفير وصف تفصيلي لاعتلالات الغدد الصم الشائعة يمكّن المتخصصين في الرعاية الصحية في البيئات التعليمية من أن يكونوا مجهزين بشكل أفضل، حيث يوجد نقص في الأطباء البيطريين السريريين المتخصصين في هذا المجال. من الضروري إجراء المزيد من الدراسات للحصول على فهم أعمق لهذه الحالات لدى الكلاب والقطط. تقدم المقالة لمحة عامة عن أمراض الغدد الصم السائدة في الحيوانات المنزلية الاليفة التي تصادف عادة في ممارسة الحيوانات الصغيرة. وهو يركز على معايير التشخيص الحالية وخيارات العلاج المعتمدة لهذه الحالات.

الكلمات المفتاحية: القطط، الكلاب، اضطرابات الغدد ، مراجعة بحثية