

**MARK S. THOMPSON**

Small Animal  
**Medical  
Differential  
Diagnosis**

THIRD EDITION



**A BOOK OF LISTS**

ELSEVIER

# **Small Animal Medical Differential Diagnosis**

---

# A Book of Lists

THIRD EDITION

**Mark S. Thompson, DVM**

*Diplomate, American Board of Veterinary Practitioners, Certified in Canine/Feline Practice, Brevard Animal Hospital, Brevard, North Carolina*

**ELSEVIER**

---

# Table of Contents

---

Cover image

Title page

Copyright

Dedication

Preface

About the Book

Acknowledgments

Part One: Clinical Signs Approach to Differential Diagnosis

Abdominal Distension

Abdominal Effusions and Ascites

Abdominal Pain, Acute

Aggressive Behavior

Alopecia

Anaphylaxis

Anorexia

Anuria and Oliguria

Anxiety and Phobias

Ascites

Ataxia and Incoordination

Blindness

Bradycardia, Sinus

Cachexia and Muscle Wasting

Collapse

Compulsive Behavior Disorders

Constipation

Coughing

Cyanosis

Deafness

Diarrhea, Acute

Diarrhea, Chronic

Dyschezia

Dysphagia  
Dyspnea  
Dysuria  
Ecchymoses  
Edema  
Epistaxis  
Erosions and Ulcers of Skin and Mucous Membranes  
Failure to Grow/Failure to Thrive  
Fever of Unknown Origin  
Flatulence  
Gagging  
Genital Dermatoses  
Halitosis  
Head Tilt  
Hematemesis  
Hematochezia  
Hematuria  
Hemoptysis  
Hemorrhage, Prolonged  
Horner Syndrome  
Hyperemia  
Hyperpigmentation  
Hyperthermia  
Hypopigmentation  
Hyphema  
Hypothermia  
Icterus (Jaundice)  
Inappropriate Elimination  
Incontinence, Fecal  
Incontinence, Urinary  
Infertility, Female  
Infertility, Male  
Joint Swelling  
Lameness  
Lymphadenopathy (Lymph Node Enlargement)  
Melena  
Muscle Wasting  
Nasal Discharge  
Nystagmus  
Obesity  
Oliguria  
Pallor

Panting  
Papules and Pustules  
Paresis and Paralysis  
Petechiae and Ecchymoses  
Pollakiuria  
Polyphagia  
Polyuria and Polydipsia  
Preputial Discharge  
Pruritus  
Ptyalism (Excessive Salivation)  
Pulse Abnormalities  
Regurgitation  
Restlessness  
Reverse Sneezing  
Scaling and Crusting  
Seizure  
Sneezing and Nasal Discharge  
Stertor and Stridor  
Stranguria, Dysuria, and Pollakiuria  
Stomatitis  
Stunted Growth  
Stupor and Coma  
Syncope  
Tachycardia, Sinus  
Tenesmus and Dyschezia  
Tremor  
Urine, Discolored  
Urticaria/Angioedema  
Vision Loss, Sudden  
Vomiting  
Vulvar Discharge  
Weakness  
Weight Gain  
Weight Loss

## Part Two: Systemic Approach to Differential Diagnosis

Mechanisms of Disease  
Section I Cardiopulmonary Disorders  
Arrhythmias  
Arterial Thromboembolism  
Aspiration Pneumonia  
Atrioventricular Valve Disease, Chronic (Mitral or Tricuspid Valve)

Canine Infectious Tracheobronchitis, Etiologic Agents Associated With

Cardiomegaly

Chylothorax

Congenital Heart Disease

Heart Failure

Heartworm Disease

Hypertension

Laryngeal and Pharyngeal Disease

Lower Respiratory Tract Disease

Mediastinal Disease

Murmurs

Myocardial Diseases

Pericardial Effusion

Pleural Effusion

Pulmonary Disease

Pulmonary Edema

Pulmonary Thromboembolism

Tachycardia, Sinus

Section II Dermatologic Disorders

Allergic Skin Disease

Alopecia, Endocrine

Claw Disorders

Erosions and Ulcerations of Skin or Mucous Membranes

Folliculitis

Otitis Externa, Chronic

Parasitic Dermatoses

Pigmentation

Pyoderma

Section III Endocrinologic and Metabolic Disorders

Acromegaly

Adrenal Tumors

Cretinism (Hypothyroidism in Puppies)

Diabetes Insipidus

Diabetic Ketoacidosis

Diabetes Mellitus

Gastrinoma (Zollinger–Ellison Syndrome)

Glucagonoma

Hyperadrenocorticism

Hyperglycemia

Hypoadrenocorticism

Hypoglycemia

Hyponatremia/hyperkalemia

Insulinoma

Parathyroidism

Pheochromocytoma

Pituitary Dwarfism

Thyroid Disease

Section IV Gastroenterologic Disorders

Chronic Constipation, Feline

Dental and Oral Cavity Diseases

Diarrhea

Diseases of the Tongue

Esophageal Disease

Fecal Incontinence

Ileus

Large Intestinal Disease

Malabsorptive Disease

Perianal Disease

Protein-Losing Enteropathy

Salivary Gland Disease

Small Intestinal Disease

Stomach Disorders

Tonsillar Disorders

Section V Hematologic Disorders

Anemia

Coagulopathies, Inherited and Acquired

Expected Hemostatic Test Results in Selected Diseases

Leukocyte Disorders

Platelet Dysfunction

Splenitis/Splenomegaly

Thrombocytopenia

Section VI Immunologic and Immune-Mediated Disorders

Autoimmune Skin Diseases

Immune-Mediated Disease

Immune System Components

Mechanisms of Immunopathologic Injury

Organ Systems Affected by Autoimmune Disorders in the Dog and Cat

Systemic Lupus Erythematosus

Section VII Infectious Disease

Anaplasmosis, Canine

Bacterial Infections, Systemic

Ehrlichiosis, Canine

Influenza, Canine

Influenza, Feline



Mycoses, Systemic

Neorickettsioses, Canine

Polysystemic Protozoal Diseases

Rocky Mountain Spotted Fever

Sepsis and Systemic Inflammatory Response Syndrome (SIRS)

Vaccines, Recommended Core vs. Noncore

Viruses, Canine

Viruses, Feline

Section VIII Joint and Bone Disorders

Arthritis

Bone Disorders

Section IX Liver and Exocrine Pancreatic Disorders

Cholangitis and Cholangiohepatitis, Feline

Exocrine Pancreatic Disease

Gallbladder and Extrahepatic Biliary Disease

Hepatic Encephalopathy

Hepatic Lipidosis, Feline

Hepatobiliary Disease

Hepatomegaly and Microhepatica

Hyperlipidemia

Pancreatitis

Portosystemic Shunt, Congenital and Acquired

Vacuolar Hepatopathy, Canine

Section X Neoplasia

Chemotherapeutic Agent Toxicity

Corticosteroid Therapy

Histiocytic Disease

Humoral Hypercalcemia

Lymphoma

Paraneoplastic Syndromes

Sarcomas

Thyroid Neoplasms

Tumors

Section XI Neurologic and Neuromuscular Disorders

Brain Disease, Congenital or Hereditary

Cognitive Dysfunction

Cranial Nerve Deficits

Head Tilt

Inflammatory Disease of the Nervous System

Intracranial Neoplasms

Myasthenia Gravis

Myositis and Myopathies

Neurologic Examination

Paroxysmal Disorders Confused with Epileptic Seizures

Peripheral Neuropathies

Spinal Cord Disease

Spinal Cord Lesions

Systemic Disease

Vestibular Disease

Section XII Ocular Disorders

Anisocoria

Blindness, Acute

Corneal Color Changes

Eyelids and Periocular Skin

Nonhealing Corneal Erosions (Ulcers) in Dogs

Ocular Manifestations of Systemic Diseases

Ocular Neoplasia

Red Eye

Retinal Detachment

Uveitis

Section XIII Toxicology

Chemical Toxicoses

Plant Toxicoses

Venomous Bites and Stings

Section XIV Urogenital Disorders

Differentiating between Urine Marking and Inappropriate Elimination in Cats

Glomerular Disease

Indications for Cystoscopy

Mammary Masses

Prostatic Disease

Proteinuria in Dogs and Cats

Pyelonephritis, Bacterial

Renal Disease (*see also* Glomerular Disease)

Reproductive Disorders

Ureteral Diseases

Urinary Tract Infection

Uroliths, Canine

Vaginal Discharge

Section XV Pain Diagnosis

Acute Pain Assessment

Acute Pain Preemptive Scoring System (examples in each category)

Chronic Pain Assessment

Section XVI FAST Ultrasound

FAST ultrasound examinations (Focused Assessment with Sonography for Trauma, Triage, and Tracking)

TFAST as an extension of the physical exam

### Part Three: Laboratory Values and Interpretation of Results

Acetylcholine Receptor Antibody

Normal range:

Activated Coagulation Time (ACT)

Normal range:

Activated Partial Thromboplastin Time (APTT)

Normal range:

Adrenocorticotrophic Hormone (ACTH), Endogenous

Normal range:

Adrenocorticotrophic Hormone (ACTH) Stimulation Test

Normal range:

Alanine Aminotransferase (ALT, Formerly SGPT)

Normal range:

Albumin

Normal range:

Alkaline Phosphatase, Serum (SAP or ALP)

Normal range:

Ammonia

Normal range:

Amylase, Serum

Normal range:

Anion Gap

Normal range:

Laboratory calculation:

Antinuclear Antibody (ANA)

Normal range:

Antithrombin (AT)

Normal range:

Arterial Blood Gases

Normal range:

Aspartate Aminotransferase (AST, Formerly SGOT)

Bartonella

Basophil Count

Normal range:

Bicarbonate ( $\text{HCO}_3^-$ )

Normal range:

Bile Acids

Normal range:

Bilirubin

Normal range:

Blood Urea Nitrogen (BUN)

Normal range:

Buccal Mucosal Bleeding Time (BMBT)

Normal range:

Calcium (Ca)

Normal range:

Cerebrospinal Fluid (CSF)

Normal range:

Chloride (Cl)

Normal range:

Cholesterol (CH)

Normal range:

Cholinesterase

Normal range:

Cobalamin

Normal range:

Complete Blood Count (CBC)

Normal range:

Coombs Test

Cortisol

Normal range:

Creatine Kinase (CK, formerly CPK)

Normal range:

Creatinine

Normal range:

Cytologic Criteria of Malignancy

Cytologic Features of Discrete Cell (Round Cell) Tumors

Cytologic Features of Mesenchymal Cells

Cytologic Features of Normal Epithelial Cells

Cytology of Ear Canal Swabs

Cytology of Nasal Swabs or Flush Specimens

Dexamethasone Suppression Tests

Disseminated Intravascular Coagulation (DIC), Diagnostic Tests

Eosinophil Count

Normal range:

Eosinophils:

Erythrocyte Count (RBC Count)

Normal range:

Folate

Normal range:

Fructosamine

Normal range:

Gamma Glutamyltransferase (GGT)  
Normal range:  
Globulin  
Normal range:  
Glucose  
Normal range:  
Glucose Tolerance Test  
Glycosylated Hemoglobin  
Heartworm Antibody, Feline  
Heartworm Antigen, Canine  
Heartworm Antigen, Feline  
Hematocrit (PCV)  
Normal range:  
Hemoglobin  
Hemolysis, Prevention in Laboratory Samples  
Immunoassays  
Insulin  
Normal range:  
Iron-Binding Capacity (Total, TIBC)/Ferritin  
Joint Fluid (Arthrocentesis)  
Normal  
Immune-mediated joint disease (nonerosive)  
Lactate  
Normal range:  
Lipase  
Normal range:  
Lymphocyte Count  
Normal range:  
Magnesium (Mg)  
Normal range:  
Mean Corpuscular Volume (MCV)  
Normal range:  
Methemoglobinemia  
Methods of Sample Collection for Cytology  
Monocyte Count  
Normal range:  
Myoglobinuria  
Neutrophil Count  
Normal range:  
Osmolality  
Packed Cell Volume  
Parathyroid Hormone (PTH)/Ionized Calcium

Normal range:

Phosphorus (P)

Normal range:

Platelet Count

Normal range:

Polymerase Chain Reaction

Potassium (K)

Normal range:

Protein, Total (TP)

Normal range:

Prothrombin Time (PT)

Normal range:

Red Blood Cell (RBC) Count

Reticulocyte Count

Sodium (Na)

Normal range:

Symmetric Dimethylarginine (SDMA) Assay

Normal range:

Thoracocentesis Fluid

Thrombocyte Count

Thyroid Function Tests

Toxoplasmosis Antibody Titer

Triglycerides

Normal range:

Trypsinogen-Like Immunoreactivity (TLI)

Pancreatic Lipase Immunoreactivity (PLI)

Normal range:

Urinalysis

Urine Cortisol/Creatinine Ratio

Urine Protein/Creatinine Ratio

von Willebrand Factor

WBC Count

Normal range:

## Index

---

# Copyright

---

# ELSEVIER

3251 Riverport Lane  
St. Louis, Missouri 63043

SMALL ANIMAL MEDICAL DIFFERENTIAL DIAGNOSIS: A BOOK OF LISTS, THIRD EDITION  
ISBN: 978-0-323-49830-2

**Copyright © 2018 Elsevier Inc. All Rights Reserved.**  
**Previous editions copyrighted 2014, 2007.**

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: [www.elsevier.com/permissions](http://www.elsevier.com/permissions).

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

## Notices

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds or experiments described herein. Because of rapid advances in the medical sciences, in particular, independent verification of diagnoses and drug dosages should be made. To the fullest extent of the law, no responsibility is assumed by Elsevier, authors, editors or contributors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

## Library of Congress Cataloging-in-Publication Data

Names: Thompson, Mark S., author.

Title: Small animal medical differential diagnosis : a book of lists / Mark S. Thompson, DVM  
Diplomate, American Board of Veterinary Practitioners Certified in Canine/Feline Practice, Brevard Animal Hospital, Brevard, North Carolina.

Description: Third edition. | St. Louis, Missouri : Elsevier Inc., [2018] | Includes index.

Identifiers: LCCN 2017046145 | ISBN 9780323498302

Subjects: LCSH: Veterinary medicine--Diagnosis, Differential. | Dogs--Diseases--Diagnosis. | Cats--Diseases--Diagnosis.

Classification: LCC SF771 .T48 2018 | DDC 636.089/6075--dc23 LC record available at  
<https://lccn.loc.gov/2017046145>

*Senior Content Strategist:* Jennifer Flynn-Briggs

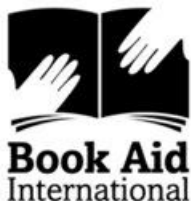
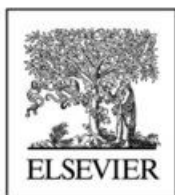
*Senior Content Development Manager:* Ellen Wurm-Cutter

*Publishing Services Manager:* Deepthi Unni

*Senior Project Manager:* Kamatchi Madhavan

*Designer:* Ashley Miner

Printed in the United States of America  
Last digit is the print number: 9 8 7 6 5 4 3 2 1



Working together  
to grow libraries in  
developing countries

[www.elsevier.com](http://www.elsevier.com) • [www.bookaid.org](http://www.bookaid.org)



---

# Dedication

---

*In memory of John Crawford, a great veterinary technician and an even greater friend.*

# Preface

---

I was gratified when Elsevier asked me to create a third edition of *Small Animal Medical Differential Diagnosis: A Book of Lists*. I envisioned an easy process of updating the lists of the second edition and adding some new material. I couldn't have been more wrong. The goal was to duplicate the format of the first and second editions: a quick, concise, and practical reference to differential diagnosis, etiology, laboratory values, and classification of clinical signs and medical disorders in dogs and cats. As I reviewed each list I was surprised to see how many needed to be revised. In fact, nearly all of the lists required additions, subtractions, or sometimes complete reorganization. A project like this one is a great illustration of how much the veterinary medical literature expands in a 4-year period. Once again, this text will be a pocket-sized, rapid reference or an electronic application. Its greatest value will be to aid the clinician in making reliable on-the-scene decisions and to allow veterinary students and interns to more fully participate in clinical rounds with their instructors. It will also be used by the more seasoned practitioner to come up with those more esoteric differentials that we sometimes forget to include in our list of potential diagnoses.

The lists in this book have been compiled from comprehensive veterinary references published by Elsevier, especially:

- Ettinger, Feldman, and Cote: *Textbook of Veterinary Internal Medicine*, eighth edition and
- Nelson and Couto: *Small Animal Internal Medicine*, fifth edition.

Also consulted for information were:

- Henry and Higginbotham: *Cancer Management in Small Animal Practice*
- Beaver: *Canine Behavior: Insights and Answers*, second edition
- Landsberg: *Behavior Problems of the Dog and Cat*, third edition
- Bonagura: *Kirk's Current Veterinary Therapy XV*
- Maggs, Miller, and Ofri: *Slatter's Fundamentals of Veterinary Ophthalmology*, fifth edition
- Willard and Tvedten: *Small Animal Clinical Diagnosis by Laboratory Methods*, fifth edition and
- Fossum: *Small Animal Surgery*, fourth edition

The reader is encouraged to consult these and other texts for more detailed information.

## About the Book

As with the first and second editions, the lists are divided into three parts and serve as a concise guide to the differential diagnosis, etiology, laboratory abnormalities, and classification of clinical signs and medical disorders in dogs and cats. Part One contains lists based on clinical signs that may be identified by the clinician. Part Two approaches the differential diagnosis from a systems perspective. Fifteen body systems are represented. Additionally, there is a new section in Part Two that features lists about Focused Assessment with Sonography for Trauma (FAST) ultrasound, a relatively new concept where point-of-care, rapid ultrasound techniques are used as an extension of the physical exam in ill or injured patients. Part Three once again is a quick reference of laboratory tests and gives typical normal ranges and differential diagnoses based on test results. Overall the book comprises approximately 430 lists, 30 of which are new to this edition. In all lists, an attempt has been made to prioritize them from least common to most common.

## Acknowledgments

I wish to thank my fellow veterinarians at Brevard Animal Hospital: Dr. Clyde Brooks, Dr. Alana Terrell, Dr. Lindsay Batson, Dr. Heather Garland, and Dr. Lauren Streifel. They were a sounding board for ideas and helped me discover deficiencies in the first two editions. In addition, our discussions about cases helped me determine new lists that needed to be generated.

---

## PART ONE

# Clinical Signs Approach to Differential Diagnosis

---

## Abdominal Distension

### Organomegaly

Hepatomegaly (infiltrative, inflammatory, lipidosis, neoplasia)  
Splenomegaly (infiltrative, inflammatory, neoplasia, hematoma)  
Renomegaly (neoplasia, infiltrative)  
Miscellaneous neoplasia (gastrointestinal [GI] tract, ovaries, uterus, pancreas, prostate, adrenal glands)  
Generalized neoplasia (carcinomatosis, lymphosarcoma)  
Granuloma (pythiosis, aspergillosis)  
Pregnancy  
Prostatomegaly

### Fluid

#### Contained in Organs

Congestion resulting from splenic torsion or volvulus, or hepatic congestion from right-sided heart failure  
Cysts (paraprostatic, perinephric, hepatic)  
Hydronephrosis  
Distended urinary bladder  
Obstruction of intestines or stomach  
Ileus  
Pyometra

#### Free Fluid in Abdomen

Transudate (portal hypertension, right-sided heart failure, hypoproteinemia secondary to protein-losing enteropathy, protein-losing nephropathy, or hepatic failure)  
Modified transudate (neoplasia, postsinusoidal portal hypertension, right-sided heart failure, heartworm-related caval syndrome, liver disease)  
Exudate (pancreatitis, feline infectious peritonitis [FIP], urine, bile, neoplasia, bowel perforation, foreign body)  
Chyle (trauma, neoplasia, infection, right-sided heart failure)  
Blood (coagulopathy, trauma, neoplasia)

### Gas

#### Contained in Organs

Gastric dilatation/volvulus  
Intestines secondary to obstruction  
Parenchymal organs infected with gas-producing bacteria (emphysematous gallbladder or urinary bladder)

#### Free in Abdomen

Iatrogenic (after laparoscopy, laparotomy)  
Rupture of GI tract or uterus

### Fat

Obesity/lipoma

### Weakened Abdominal Musculature

Hyperadrenocorticism

## **Feces**

Obstipation/megacolon



## **Abdominal Effusions and Ascites**

**Transudate (< 1000 Cells, < 2.5 Total Solids, < 1.017 Specific Gravity)**

### **Portal Hypertension**

Presinusoidal or sinusoidal liver disease  
Right-sided heart failure

### **Hypoalbuminemia (see Albumin p. 300)**

Liver failure  
Protein-losing enteropathy

### **Glomerulopathy**

**Modified Transudate (> 1000 but < 10,000 Cells, 2.5-5.0 Total Solids, < 1.025 Specific Gravity)**

### **Postsinusoidal Portal Hypertension**

### **Right-Sided Heart Failure**

Heartworm-related caval syndrome  
Liver disease

### **Neoplasia**

## **Increased Hydrostatic Pressure**

## **Vasculitis**

**Exudate (> 5000 Cells, > 3.0 Total Solids, > 1.025 Specific Gravity)**

### **Nonseptic**

Pancreatitis  
FIP  
Urine  
Bile  
Neoplasia (mesothelioma, lymphoma, carcinomatosis, any mass that causes lymphatic or vascular obstruction)

### **Septic**

Bowel perforation  
Foreign body

## **Chyle**

Trauma  
Neoplasia  
Infection  
Right-sided heart failure

## **Blood**

Coagulopathy  
Trauma  
Neoplasia (hemangiosarcoma, hepatocellular carcinoma)  
Iatrogenic (postsurgical)

## **Abdominal Pain, Acute**

### **Gastrointestinal System**

Gastrointestinal ulceration  
Foreign body  
Gastric dilation/volvulus  
Gastroenteritis  
Obstipation  
Colitis  
Neoplasia  
Adhesions  
Intestinal ischemia  
Intestinal spasm  
Flatulence

### **Urogenital System**

Lower urinary tract infection  
Lower urinary tract obstruction  
Nonseptic cystitis (idiopathic cystitis—cats)  
Prostatitis/prostatic neoplasia  
Uroliths/renoliths/ureterolith  
Pyelonephritis  
Neoplasm  
Metritis  
Pyometra/uterine rupture  
Uterine torsion (rare)  
Testicular torsion  
Mastitis  
Dystocia  
Ovarian cyst

### **Pancreatitis**

### **Spleen**

Rupture  
Neoplasm  
Infection  
Torsion

### **Peritoneum**

Peritonitis

- Septic
- Nonseptic (e.g., uroabdomen)

Adhesions  
Mesenteric neoplasia, volvulus, inflammation

### **Hepatobiliary**

Hepatitis  
Hepatic abscess  
Hepatic trauma, rupture  
Hepatobiliary neoplasia

Cholelithiasis or cholecystitis  
Cholangiohepatitis

## **Musculoskeletal**

Fractures  
Intervertebral disk disease  
Diskospondylitis  
Abscess  
Strangulated hernia

## **Miscellaneous**

Adrenalitis (associated with hypoadrenocorticism)  
Heavy metal intoxication  
Vasculopathy

- Rocky Mountain spotted fever
- Infarct

Autonomic (abdominal) epilepsy  
Iatrogenic

- Misoprostol
- Bethanechol
- Postoperative pain

# Aggressive Behavior

## Cats

### Pathophysiologic Causes of Feline Aggression

- Rabies
- Hyperthyroidism
- Seizures (epilepsy, central nervous system inflammation)
- Paradoxical effects of therapeutic drugs (e.g., benzodiazepines)
- Toxins (side effects)
- Cognitive dysfunction
- Brain neoplasia

### Species-Typical Patterns of Feline Aggression Toward Humans

- Defensive response when threatened (may freeze, retreat, climb, or hide but aggression eventually becomes an option)
- Play/predatory/attention-seeking response
- Aggression as a response to frustration (also known as redirected aggression)
- Aggression that arises as a result of disease processes (see [Pathophysiologic Causes of Feline Aggression](#) earlier)
- Interspecies aggression (either fear induced or territorial/resource guarding)

## Dogs

### Pathophysiologic Causes of Canine Aggression

- Rabies
- Seizure activity
- Intracranial neoplasia
- Cerebral hypoxia
- Neuroendocrine disturbances

### Species-Typical Patterns of Canine Aggression

- Fear related
- Conflict related
- Resource guarding
- Territorial/protective
- Intraspecific (intradog)
- Redirected
- Predatory
- Pain/medical/irritable
- Play
- Maternal/hormonal
- Idiopathic

# Alopecia

## Inflammatory Alopecia

### Traumatic

Allergy (flea, atopy, food)

Parasitic dermatitis (flea, scabies, *Cheyletiella* spp., lice, chiggers, etc.)

### Infectious

Pyoderma

Demodicosis

Dermatophytosis

Viral

Leishmaniasis

*Malassezia* spp.

### Immune Mediated

Sebaceous adenitis

Superficial pemphigus

Alopecia areata

Erythema multiforme

Systemic lupus erythematosus (SLE), discoid lupus erythematosus (DLE)

Epitheliotropic lymphoma

Vasculitis

### Atrophic

Dermatomyositis

Cutaneous vasculitis

Postvaccinal alopecia

Lymphocytic mural folliculitis

Paraneoplastic exfoliative dermatitis

Pseudopelade

## Noninflammatory Alopecia

### Hormonal

Hyperadrenocorticism

Iatrogenic Cushing syndrome

Hypothyroidism

Sex hormone imbalance

Alopecia X

Hyperthyroidism (cat)

## Canine and Feline Pinnal Alopecia

### Canine Pattern Baldness

### Canine Follicular Dysplasia

Trichorrhexis nodosa

Pili torti

Color mutant alopecia

Black hair follicular dysplasia

Canine flank alopecia

Anagen and telogen effluvium

### **Feline Congenital/Hereditary**

Alopecia universalis (Sphinx)  
Congenital hypotrichosis  
Hair shaft dysplasia (Abyssinian)  
Follicular dysplasia (Cornish Rex)  
Pili torti

### **Other**

Anagen effluvium  
Telogen defluxion  
Paraneoplastic alopecia  
Cyclic follicular dysplasia (seasonal flank alopecia)  
Postclipping alopecia  
Cicatricial alopecia  
Feline preauricular alopecia  
Feline acquired symmetric alopecia  
Psychogenic alopecia

# Anaphylaxis

## Venoms

Insects of Hymenoptera order (bees, hornets, ants)  
Spiders (brown recluse, black widow)  
Snakes (rattlesnakes, copperheads, water moccasins)  
Lizards (Gila monster, Mexican beaded lizard)

## Drugs

Antibiotics (penicillins, sulfonamides, lincomycin, cephalosporins, aminoglycosides, tetracyclines, chloramphenicol, polymyxin B)  
Vaccines  
Allergen extracts  
Blood products  
Parasiticides (dichlorophen, levamisole, piperazine, dichlorvos, diethylcarbamazine, thiacetarsamide)  
Anesthetics/sedatives (acepromazine, ketamine, barbiturates, lidocaine, bupivacaine, narcotics, diazepam)  
Nonsteroidal antiinflammatory drugs (NSAIDs)  
Hormones (insulin, corticotropin, vasopressin, parathyroid hormone, glucocorticoids)  
Aminophylline  
Chemotherapeutics (doxorubicin, l-asparaginase, docetaxel, paclitaxel, etoposide)  
Iodinated contrast media  
Neostigmine  
Amphotericin B  
Enzymes (trypsin, chymotrypsin)  
Vitamins (vitamin K, thiamine, folic acid)  
Dextrans and gelatins  
Calcium disodium edetate

## Foods

Milk, egg white, shellfish, legumes, citrus fruits, chocolate, grains

## Physical Factors

Cold, heat, exercise



## **Anorexia**

### **Primary Anorexia**

- Disinterest in eating; primary disease of appetite or satiety centers, rare

### **Secondary Anorexia (Common with Virtually any Systemic Disease)**

- Associate with nausea (gastrointestinal [GI] inflammation, ileus, delayed gastric emptying, vestibular disease, drug-induced nausea, food aversion)

### **Pseudoanorexia (Reluctance to Eat)**

- Retrobulbar abscess
- Intraoral masses, foreign bodies
- Mandibular fractures/temporomandibular joint disease
- Masticatory myositis
- Periodontal disease, gingivostomatitis
- Salivary mucocele, sialadenitis, salivary tumor
- Oropharyngeal dysphagia
- Esophageal masses or foreign bodies
- Nasal disease
- Unpalatable diet
- Anosmia

### **Behavioral**

- Social stress or conflict
- Anxiety
- Loss of companion

# Anuria and Oliguria

## Prerenal Azotemia

Dehydration/hypovolemia

## Acute Renal Failure

One third of cases are anuric, one third are oliguric, and one third are nonoliguric; more likely to be oliguric/anuric with severe renal toxicosis

Toxic: exogenous (drugs, biologic or environmental toxins), endogenous (calcium, pigments)

Infectious: pyelonephritis, leptospirosis, infectious canine hepatitis, borreliosis, sepsis

Ischemia: progression of prerenal azotemia, NSAIDs, vascular disease (avulsion, thrombosis, stenosis), shock, decreased cardiac output, deep anesthesia, extensive surgery, hypothermia, hyperthermia, hyperviscosity (polycythemia vera, multiple myeloma, extensive cutaneous burns, transfusion reaction, disseminated intravascular coagulation [DIC])

Immune mediated: acute glomerulonephritis, SLE, transplant rejection, vasculitis

Neoplasia: lymphoma

Systemic disease with renal manifestations

- Infections (FIP, borreliosis, babesiosis, leishmaniasis, bacterial endocarditis)
- Pancreatitis
- Sepsis
- Multiple organ failure
- Heart failure
- SLE
- Hepatorenal disease
- Malignant hypertension

## Postrenal Azotemia

Obstruction (may appear similar to anuria/oliguria)

# Anxiety and Phobias

## Fears and Phobias

Fear: apprehension associated with the presence of an object, individual, or sound; may be normal or abnormal, depending on context

Phobia: quickly developed, immediate, profound abnormal response to a stimulus leading to catatonia or panic

### People

Babies, children, elderly

People in uniform

People who appear different from family members

- Color, height, facial hair

Disabled people

Men or women, depending on circumstance

### Animals

Same species

Other species

### Noise

Especially gunshots, fireworks, thunder

### Places

**Veterinary clinic, grooming facility, kennel**

**Car, moving vehicle**

**Crate or specific room**

**Type of flooring or surface**

## Anxiety

### Separation Anxiety

#### Initiators

Change in owner's routine

Owner returning to school or work

Move to new home

Visit to new environment

After stay in kennel

New baby, new pet, new partner

Medical, cognitive

#### Common Features of Separation Anxiety

Hyperattached to owner

Signs of anxiety as owner leaves

Problems manifest when owner absent or when pet unable to gain access to owner

Problem behavior begins shortly after owner leaves

May even occur during short absences

Pet shows exuberant greeting behavior

## **Generalized Anxiety**

Poorly socialized, nervous pet

### **Signs of anxiety**

- Hypervigilance, scanning
- Increased motor activity (restlessness, pacing, circling)
- Vocalization/whining
- Displacement behaviors: out-of-context grooming and scratching, yawning, lip licking, whining and barking, destructive, digging
- Changes in social soliciting behavior: increase or decrease in attention seeking
- Hiding, escape attempts
- Physiologic signs (trembling, dilated pupils, ptyalism, piloerection, ↑ respiratory rate, ↑ heart rate, urination, defecation, vomiting, anal sac expression)
- Decreased appetite.

## Ascites

See [Abdominal Effusions and Ascites](#).

# **Ataxia and Incoordination**

## **Forebrain Disease**

Typically, mild ataxia and other neurologic signs predominate.

- Generalized disease: generalized ataxia

- Unilateral disease: contralateral conscious proprioceptive deficits, mild gait disturbance

- Postictal paraparesis: transient in nature

Paraparesis may be a side effect of anticonvulsant therapy (especially potassium bromide).

## **Brain Stem**

Hemiparesis or tetraparesis; lesions severe enough to cause paralysis usually result in respiratory arrest.

Vestibular nuclei may be affected, causing vestibular ataxia, head tilt, and nystagmus; distinguish central vestibular disease from peripheral vestibular disease by presence of ipsilateral conscious proprioceptive deficits.

## **Peripheral Vestibular Disease**

Generalized ataxia accompanied by head tilt, rotary or horizontal nystagmus, positional strabismus, and oculovestibular eye movements

- Conscious proprioceptive deficits absent

## **Cerebellum**

Lesions cause dysmetria, usually hypermetria.

- Unilateral lesions cause ipsilateral signs.

## **Cervical Spinal Cord**

May cause forelimb monoparesis (lesions affecting spinal segments C6-T2), hemiparesis, tetraparesis; may progress to paralysis

## **Thoracic (T3-L3) Spinal Cord**

Mild to marked rear limb ataxia, paraparesis, paraplegia, monoparesis, or monoplegia

Rear limb reflexes exaggerated

Reduced to absent panniculus reflex caudal to lesion

## **Lumbosacral (L4-S2) Spinal Cord**

Mild to marked rear limb ataxia, paraparesis, paraplegia, monoplegia

Reduced to absent rear limb reflexes

May see bladder and anal sphincter hypotonia

## **Peripheral Nerve**

Mild to marked ataxia, paresis, paralysis of one or more limbs

Degenerative, inflammatory, toxic, traumatic neuropathies

Hyporeflexia usually seen

Paresis or paralysis of muscle or muscles innervated by affected nerve



## Blindness

### Corneal Lesions

Edema (trauma, glaucoma, immune-mediated keratitis such as keratouveitis caused by canine adenovirus-1, endothelial dystrophy, neurotropic keratitis)  
Keratoconjunctivitis sicca  
Exposure keratitis  
Superficial keratitis (pannus)  
Corneal melanosis (entropion, ectropion, lagophthalmos, facial nerve paralysis)  
Cellular infiltrate (bacterial, viral, fungal)  
Dystrophies (lipid, genetic)  
Fibrosis (scar)

### Aqueous Humor Lesions

Fibrin (anterior uveitis: many causes)  
Hypopyon (immune-mediated, neoplastic [lymphosarcoma], infectious [blastomycosis, cryptococcus, histoplasmosis, coccidioidomycosis, toxoplasmosis, FIP, protothecosis, brucellosis, septicemia])  
Hyphema (trauma, blood-clotting deficiencies, ehrlichiosis, rickettsia, systemic hypertension, retinal detachment, neoplasia)  
Lipid (hyperlipidemia with concurrent anterior uveitis to disrupt the blood–aqueous barrier)

### Lens Lesions

Cataracts (genetic, metabolic/diabetic, nutritional, traumatic, toxic, retinal degeneration, hypocalcemia, electric shock, chronic uveitis, lens luxation)

### Vitreous Humor Lesions

Hemorrhage (trauma, systemic hypertension, clotting deficiency, neoplasia, retinal detachment)  
Hyalitis (numerous infectious diseases such as FIP, penetrating injury causing cellular infiltrate)

### Retinal Lesions

Glaucoma  
Sudden acquired retinal degeneration (SARD)  
Progressive retinal atrophy  
Central progressive retinal atrophy  
Toxicity (fluoroquinolone administration in cats)  
Systemic hypertension  
Retinal detachment

- Exudative/transudative (systemic hypertension, mycoses, rickettsial, toxoplasmosis, viral, bacterial, fungal)
- Neoplasia
- Retinal dysplasia
- Hereditary/congenital (e.g., Collie eye anomaly)

### Failure to Transmit Visual Message

Viral infections (canine distemper, FIP)  
Systemic and ocular mycoses (blastomycosis, cryptococcosis, histoplasmosis, coccidioidomycosis)  
Neoplasia  
Traumatic avulsion of optic nerve (traumatic proptosis)  
Granulomatous meningoencephalitis  
Hydrocephalus



Optic nerve hypoplasia  
Coloboma  
Immune-mediated optic neuritis

## **Failure to Interpret Visual Message**

Canine distemper virus  
FIP  
Granulomatous meningoencephalitis  
Systemic mycoses  
Trauma  
Heat stroke  
Hypoxia  
Hydrocephalus  
Hepatoencephalopathy  
Neoplasia  
Storage diseases  
Postictal  
Meningitis

## Bradycardia, Sinus

Normal variation (fit animal)

Hypothyroidism

Hypothermia

Drugs (tranquilizers, anesthetics,  $\beta$ -blockers, calcium entry blockers, digitalis)

Increased intracranial pressure

Brain stem lesion

Severe metabolic disease (e.g., uremia)

Ocular pressure

Carotid sinus pressure

High vagal tone

Cardiac arrest (before and after)

Sinus node disease

Airway obstruction (causing high vagal tone)

# Cachexia and Muscle Wasting

## Cachexia

Certain chronic disease processes stimulate the release of cytokines that suppress appetite and stimulate hypercatabolism.

Cardiac disease  
End-stage renal disease  
Chronic infection  
Chronic fever  
Chronic inflammation  
Neoplasia

## Muscle Wasting

### Endocrine Disease

Hyperadrenocorticism  
Hyperthyroidism  
Hyperparathyroidism

### Starvation

Underfeeding  
Poor-quality feed  
Competition for food  
Dental disease  
Lactation, pregnancy  
Increased work  
Extreme cold environment

### Impaired Ability to Use or Retain Nutrients

Dysphagia, regurgitation, vomiting  
Maldigestion  
Malabsorption  
Parasitism  
Histoplasmosis  
Exocrine pancreatic insufficiency  
Diabetes mellitus  
Protein-losing nephropathy or gastroenteropathy

### Inflammatory Myopathies

Masticatory myositis  
Dermatomyositis  
Canine idiopathic polymyositis  
Feline idiopathic polymyositis

### Protozoal Myositis

*Toxoplasma gondii*  
*Neospora caninum*

### Inherited Myopathies

Muscular dystrophy  
Hereditary Labrador Retriever myopathy

### Neurologic Disorders

Spinal and peripheral neuropathies

Disuse atrophy

# Collapse

## Differential Diagnosis of Collapse

### Cardiovascular

- Congestive heart failure
- Arrhythmia
- Arterial thromboembolism
- Pulmonary hypertension
- Cardiac tamponade

### Respiratory

- Laryngeal paralysis
- Tracheal collapse
- Asthma
- Brachycephalic upper airway disease
- Pulmonary edema
- Pleural effusion
- Pneumonia
- Pharyngeal or laryngeal obstruction (mass, foreign body)
- Lung lobe torsion

### Metabolic/endocrine

- Anemia
- Hypoglycemia
- Shock
- Sepsis
- Heat stroke
- Hypoadrenocorticism
- Anaphylaxis
- Hypocalcemia
- Hypokalemia

### Brain/cranial nerves

- Canine geriatric vestibular syndrome
- Feline idiopathic vestibular syndrome
- Hemorrhage
- Neoplasia
- Intoxication
- Infarct
- Encephalitis
- Hydrocephalus

### Spinal cord

- Intervertebral disc disease
- Trauma
- Neoplasia
- Discospondylitis
- Hemorrhage
- Fibrocartilaginous embolism
- Meningitis/myelitis
- Cervical spondylomyelopathy (Wobblers)

### Partial seizures

- Idiopathic epilepsy

- Brain disease

### **Neuromuscular/musculoskeletal**

- Tick paralysis
- Polyradiculoneuritis
- Botulism
- Myasthenia gravis
- Polyarthritis, polyneuropathy, polymyositis

### **Exercise-induced collapse**

# Compulsive Behavior Disorders

## Compulsive Disorders in Dogs

### Locomotor

Spinning or tail chasing  
Stereotypic pacing/circling/jumping  
Fixation; staring/barking/freezing/scratching  
Chasing lights, reflections, shadows  
Barking; intense/rhythmic/difficult to interrupt  
Head bob/tremor/head shaking  
Attacking food bowl, attacking inanimate objects

### Apparent Hallucinatory

Air biting or fly snapping  
Staring, freezing, startled  
Star/sky gazing

### Self-Injurious or Self-Directed

Tail attacking, mutilation, growl/attack legs or rear  
Face rubbing/scratching  
Acral lick dermatitis, licking/chewing/barbering  
Nail biting  
Flank sucking  
Checking rear

### Oral

Sucking/licking  
Pica, rock chewing  
Polydipsia/polyphagia  
Licking of objects/owners

## Compulsive Disorders in Cats

### Locomotor

Skin ripple/agitation/running, feline hyperesthesia  
Circling  
Freezing  
Excessive/intense chasing of imaginary objects  
Excessive vocalization/howling

### Apparent Hallucinatory

Staring at shadows/walls  
Startle  
Avoiding imaginary objects

### Self-Injurious or Self-Directed

Tail attacking, mutilation, growl/attack legs or rear  
Face scratching/rubbing  
Chewing/licking/barbering/overgrooming  
Nail biting  
Hyperesthesia

### Oral

Wool sucking  
Pica  
Polydipsia/polyphagia  
Licking of objects/owners



## Constipation

### Dietary Causes

Excessive fiber in dehydrated patient  
Ingestion of hair, bones, indigestible materials

### Colonic Obstruction

Deviation of rectal canal: perineal hernia  
Intraluminal or intramural disorders

- Tumor
- Granuloma
- Cicatrix
- Rectal foreign body
- Congenital stricture

Pseudocoprostasis

Perineal hernia

Extraluminal disorders

- Tumor
- Granuloma
- Abscess
- Healed pelvic fracture
- Prostatomegaly
- Prostatic or paraprostatic cyst
- Sublumbar lymphadenopathy

### Behavioral or Environmental Causes

Change in routine  
Soiled or absent litter box  
Refusal to defecate in house  
Inactivity

### Drugs

Opiates  
Anticholinergics  
Sucralfate  
Barium

### Refusal to Defecate

Pain in rectal or perineal area (perianal fistulas)  
Inability to posture to defecate (orthopedic or neurologic problem)

### Colonic Weakness

#### Systemic Disease

Hypercalcemia  
Hypokalemia  
Hypothyroidism  
Chagas disease

#### Localized Neuromuscular Disease

Spinal cord disease

Pelvic nerve damage  
Dysautonomia  
Chronic dilatation of colon/irreversible stretching of colonic musculature

## **Miscellaneous Causes**

Severe dehydration  
Idiopathic megacolon (cats)

## Coughing

### Disorders of Upper Airway

#### Inflammatory

Pharyngitis  
Tonsillitis  
Tracheobronchitis  
Chronic bronchitis  
Allergic bronchitis  
Bronchiectasis  
Collapsed trachea  
*Oslerus osleri* infection

#### Neoplastic

Mediastinal  
Laryngeal  
Tracheal

#### Allergic

Bronchial asthma

#### Other

Bronchial compression: left atrial enlargement, hilar lymphadenopathy  
Foreign body  
Inhalation  
Tracheal stenosis

### Disorders of Lower Respiratory Tract

#### Inflammatory

##### Pneumonia

Bacterial  
Viral: canine distemper virus  
Fungal: blastomycosis, histoplasmosis, coccidioidomycosis  
Protozoal: toxoplasmosis, pneumocystis pneumonia  
Aspiration pneumonia

##### Granuloma, Abscess

##### Chronic Pulmonary Fibrosis

#### Parasitic Disease

Heartworm disease (*Dirofilaria immitis*)  
Lungworm disease (*Aelurostrongylus abstrusus*—cat; *Paragonimus kellicotti*—dog, cat; *Capillaria aerophilus*—dog, cat; *Filaroides hirthi*—dog; *Crenosoma vulpis*—dog; *Angiostrongylus vasorum*—dog)

#### Neoplasia

Primary or metastatic  
Lymphoma

#### Cardiovascular

Left-sided heart failure: pulmonary edema

Pulmonary thromboembolism

## **Noncardiogenic Pulmonary Edema**

### **Allergic**

Eosinophilic pneumonitis

Eosinophilic pulmonary granulomatosis

Pulmonary infiltrate with eosinophils (PIE)

### **Other**

Lung lobe torsion

Systemic bleeding disorder

Pleural effusion

Neoplasia of chest wall

# Cyanosis

## Central Cyanosis

### Cardiac

#### Intracardiac

Tetralogy of Fallot

Atrial or ventricular septal defect with pulmonic stenosis, tricuspid valve dysplasia, or pulmonary hypertension

Transposition complexes (double outlet right ventricle, other)

#### Extracardiac

Pulmonary arteriovenous fistulas

Patent ductus arteriosus (reversed)

### Pulmonary

#### Hypoventilation

Pleural effusion

Pneumothorax

Respiratory muscle failure (fatigue, neuromuscular disease)

Anesthetic overdose

Primary neurologic disease

#### Obstruction

Laryngeal paralysis

Foreign body in airway

Mass lesion of large airway (neoplasia, parasitic, inflammatory)

Low oxygen concentration of inspired air (high altitude, anesthetic complications)

#### Ventilation-Perfusion Mismatch

Pulmonary thromboembolism

Pulmonary infiltrate (edema, inflammation/infection, neoplasia, acute respiratory distress

syndrome, chronic obstructive pulmonary disease, fibrosis, pulmonary contusions/hemorrhage)

### Methemoglobinemia

## Peripheral Cyanosis

Central cyanosis (heart failure)

Decreased arterial supply

Peripheral vasoconstriction (hypothermia, shock)

Arterial thromboembolism

Low cardiac output

Obstruction of venous drainage

- Tourniquet or foreign object (e.g., rubber band)
- Venous thrombosis
- Right-sided heart failure

## Deafness

### Congenital Sensorineural Deafness

#### Inherited

Many breeds of dogs

- Dalmatians
- Merle or dapple coat patterns in Collies, Shetland Sheepdogs, Great Danes, Dachshunds
- Piebald pattern in Dalmatians, Bull Terriers, Great Pyrenees, Sealyham Terriers, Greyhounds, Bulldogs, and Beagles
- Many other dog breeds affected

White cats with blue irides and white coloration in some breeds of dogs

### Congenital Acquired Sensorineural Deafness

In utero exposure to bacteria, ototoxic drugs, low oxygen tensions, or trauma

### Acquired Late-Onset Conductive Deafness

Lack of transmission of sound through tympanic membrane and auditory ossicles

Otitis externa/media

Otic neoplasia

Polyps

Trauma-induced fluid accumulation in middle ear

Atresia of tympanum or ossicles

Fused ossicles

Stenosis of ear canal leading to accumulation of fluid in middle ear

Total ear canal ablation

### Acquired Late-Onset Sensorineural Deafness

Presbycusis (age-related hearing loss)

Ototoxicity

Chronic exposure to loud noise

Hypothyroidism

Trauma

Bony neoplasia

## Diarrhea, Acute

### Diet

Intolerance/allergy  
Rapid dietary change  
Bacterial food poisoning  
Dietary indiscretion  
Poor-quality food

### Parasites

Helminths  
Protozoa (*Giardia*, *Trichomonas*, *Coccidia* spp.)

### Infections

Viral (parvovirus, coronavirus, feline leukemia virus [FeLV], feline immunodeficiency virus [FIV], canine distemper virus, rotavirus)  
Bacterial (*Salmonella* spp., *Clostridium perfringens*, *Escherichia coli*, *Campylobacter jejuni*, *Yersinia enterocolitica*, other bacteria)  
Rickettsial  
• Salmon poisoning

### Other Causes

Hemorrhagic gastroenteritis  
Intussusception  
Irritable bowel syndrome  
Toxins (chemicals, heavy metals, toxic plants, spoiled foods, garbage)  
Drugs (antibiotics, cancer chemotherapeutic agents, anthelmintics, nonsteroidal anti-inflammatory drugs [NSAIDs], digitalis, lactulose)  
Pancreatitis  
Hypoadrenocorticism  
Pyometra  
Peritonitis

## Diarrhea, Chronic

### Small Bowel Diarrhea

Food intolerance or allergy  
Inflammatory bowel disease  
GI lymphoma  
Pancreatic exocrine insufficiency  
Chronic parasitism (hookworm, *Giardia*)  
Histoplasmosis  
Intestinal lymphangiectasia  
Partial obstruction  
Pancreatic carcinoma  
Gastrinoma  
Liver disease (hepatocellular failure, cholestasis)  
Endocrine disease (hypoadrenocorticism, hypothyroidism, hyperthyroidism)  
Renal disease (uremia, nephrotic syndrome)  
Chronic intussusception  
Small intestinal bacterial overgrowth  
Pythiosis

### Large Bowel Diarrhea

Food intolerance or allergy  
Parasitism (whipworm, *Giardia*, *Trichomonas*, *Heterobilharzia*)  
Clostridial colitis  
Irritable bowel syndrome (fiber-responsive)  
Histoplasmosis  
Pythiosis  
Inflammatory bowel disease

- Lymphocytic-plasmacytic colitis
- Eosinophilic colitis
- Chronic ulcerative colitis
- Histiocytic ulcerative colitis (Boxers)

Neoplasia (lymphoma, adenocarcinoma)  
FeLV/FIV (infections secondary to these viruses)



## Dyschezia

See [Tenesmus and Dyschezia](#).

# Dysphagia

## Oral Lesions

Fractured bones or teeth

Periodontitis

Trauma (laceration, hematoma)

Feline resorptive lesions (caries)

Osteomyelitis

Retrobulbar abscess/inflammation

Temporal-masseter myositis

Stomatitis, glossitis, pharyngitis, gingivitis, tonsillitis, sialadenitis

- Immune-mediated disease
- Feline herpesvirus, calicivirus, leukemia virus, immunodeficiency virus
- Lingual foreign bodies or granulomas
- Tooth root abscess
- Uremia
- Caustic chemicals

Cleft palate

Lingual frenulum disorder

Cricopharyngeal achalasia/asynchrony

## Obstructive Lesion

Esophageal stricture/foreign object

Esophagitis

Electric cord burns

Neoplasia (malignant or benign)

Inflammatory (abscess, polyp, granuloma)

Lymphadenopathy

Eosinophilic granuloma

Foreign object (oral, pharyngeal, laryngeal)

Sialocele

Nasopharyngeal polyp

## Neuromuscular Disease

Myasthenia gravis

Acute polyradiculitis

Masticatory myositis

Tick paralysis

Botulism

Polymyositis

Temporomandibular joint disease

Rabies

Trigeminal nerve paralysis or neuritis

Neuropathies of cranial nerves V, VII, IX, X, or XII

Brain stem disease

Tetanus

Hypothyroidism

## Dyspnea

### Inspiratory Dyspnea

#### Nasal Obstruction

Rhinitis

- Viral: feline herpesvirus, feline calicivirus, canine distemper virus
- Bacterial
- Fungal: aspergillosis, cryptococcosis, penicilliosis, rhinosporidiosis

Neoplasia: adenocarcinoma, squamous cell carcinoma, fibrosarcoma, osteosarcoma, chondrosarcoma, lymphoma, transmissible venereal tumor

Stenotic nares

Nasal foreign body

Thick nasal discharge of any etiology

#### Pharyngeal or Laryngeal Disease

Elongated soft palate, everted laryngeal sacculles

Neoplasia/mass, abscess, granuloma, extraluminal mass

Nasopharyngeal polyp

Foreign body

Laryngeal paralysis, acute/obstructive laryngitis, laryngeal collapse, laryngeal trauma

#### Extrathoracic Trachea

Collapsing trachea

Tracheal hypoplasia

Tracheal trauma/stricture, foreign body, neoplasia

### Expiratory or Mixed Dyspnea

#### Intrathoracic Trachea and Bronchi

Collapsing trachea or main-stem bronchus

Trauma, stricture, foreign body, neoplasia

Small airway disease

Feline asthma

Bronchitis

Smoke inhalation

Bronchopneumonia

#### Pulmonary Parenchymal Disease

Pneumonia (viral, bacterial, fungal, protozoal, aspiration)

Pulmonary edema

Pulmonary thromboembolism

Bronchial asthma

Chronic obstructive lung disease

#### Parasites/Severe Infestations/Heartworm, Lungworms

Pulmonary fibrosis

Neoplasia

#### Pleural Space Disease

Pleural effusion

Pneumothorax

Pleural space masses

Diaphragmatic hernia

## **Noncardiopulmonary Disease**

Severe anemia

Hypovolemia

Acidosis

Hyperthermia

Neurologic disease

## Dysuria

See [Stranguria, Dysuria, and Pollakiuria](#).

## Ecchymoses

See [Petechiae and Ecchymoses](#).

## Edema

### Increased Hydrostatic Pressure

#### Impaired Venous Return

Congestive heart failure  
Constrictive pericarditis  
Ascites (cirrhosis)  
Budd–Chiari syndrome  
Venous obstruction or compression (thrombosis, external pressure, extremity inactivity)  
Iatrogenic overhydration  
Heartworm disease

#### Small-Caliber Arteriolar Dilatation

Heat  
Neurohumoral dysregulation

### Reduced Plasma Osmotic Pressure

#### Hypoproteinemia

Cirrhosis (ascites)  
Malnutrition  
Protein-losing enteropathy  
Protein-losing glomerulonephropathy (nephrotic syndrome)  
Lymphangiectasia

### Lymphatic Obstruction

Various inflammatory causes  
Neoplasia  
Postsurgical  
After radiation therapy

### Sodium Retention

Excessive dietary intake with renal disease  
Renal hypoperfusion  
Increased renin–angiotensin–aldosterone secretion

### Inflammation

Acute and chronic  
Angiogenesis

### Increased Microvascular Permeability

Sepsis  
Acute respiratory distress syndrome  
Pancreatitis  
Infection (fungal, bacterial, viral)

### Mixed Mechanisms

Noncardiogenic pulmonary edema (head trauma, seizures, electrocution, upper airway obstruction)  
Anaphylaxis  
Organ torsion





# Epistaxis

## Systemic Causes

Thrombocytopenia

- Decreased production of thrombocytes (infectious, myelophthisis secondary to neoplasia, drugs, immune-mediated phenomena)
- Increased destruction (immune mediated, microangiopathy)
- Increased consumption (DIC, vasculitis, hemorrhage)

Thrombocytopathia

- Primary (von Willebrand disease)
- Secondary (uremia, ehrlichiosis, multiple myeloma, drugs such as NSAIDs)

Coagulation factor defects (e.g., hemophilia A and B)

Acquired coagulopathies (anticoagulant rodenticides, hepatic failure)

Increased capillary fragility (hypertension, hyperviscosity syndromes [multiple myeloma, ehrlichiosis, leishmaniasis], hyperlipidemia, thromboembolic disease)

Polycythemia

Systemic hypertension

## Local Causes

Neoplasia (nasal adenocarcinoma, lymphoma, benign polyps)

Foreign body

Bacterial infection (usually secondary; rarely, *Bordetella*, *Pasteurella*, or *Mycoplasma* can be primary cause of epistaxis)

Fungal rhinitis (*Aspergillus*, *Cryptococcus* spp.)

Dental disease with oronasal fistulation

Nasal parasites: *Pneumonyssus caninum* (nasal mite), *Eucoleus boehmi* (formerly *Capillaria* spp.), *Cuterebra* spp.

Eosinophilic and lymphoplasmacytic rhinitis (uncommon)

Arteriovenous malformations

# Erosions and Ulcers of Skin and Mucous Membranes

## Canine Diseases

### Infectious

- Bacterial pyoderma
- Surface: acute moist dermatitis (pyotraumatic dermatitis), intertrigo
- Deep: folliculitis/furunculosis (including pyotraumatic folliculitis), oral bacterial infections

### Fungal

- Yeast infections (*Malassezia pachydermatis*, *Candida* spp.), systemic/subcutaneous

### Parasitic

- Demodecosis

### Metabolic

- Calcinosis cutis (hyperadrenocorticism)
- Uremia/renal failure
- Necrolytic migratory erythema/metabolic epidermal necrosis

### Neoplastic

- Epitheliotropic lymphoma
- Squamous cell carcinoma

### Physical, Chemical

- Drug reactions
- Solar injury
- Thermal injury (freeze, burn)
- Urine scald

### Immune Mediated/Autoimmune

- DLE, vesicular cutaneous erythematosis
- Pemphigus group
- Uveodermatologic syndrome
- Miscellaneous autoimmune subepidermal vesiculobullous diseases: bullous pemphigoid, epidermolysis bullosa acquisita, linear IgA bullous disease, mucocutaneous pemphigoid, bullous systemic lupus type 1

### Miscellaneous

- Arthropod bites
- Dermatomyositis
- Dystrophic epidermolysis bullosa
- Idiopathic ulceration of Collies
- Junctional epidermolysis bullosa
- Toxic epidermal necrolysis/erythema multiforme
  - Junctional epidermolysis bullosa
  - Acral mutilation syndrome (French Spaniel, German and English Pointers)
  - Cutaneous asthenia (Ehler–Danlos syndrome)

## Feline Diseases

### Infectious

- Viral: calicivirus and herpesvirus
- Bacterial: atypical mycobacteriosis

- Fungal: subcutaneous (e.g., sporotrichosis) and systemic mycoses (e.g., cryptococcosis)

### **Metabolic**

- Uremia/renal disease

### **Neoplastic**

- Fibrosarcoma
- Lymphoma
- Squamous cell carcinoma

### **Physical/Chemical**

- Drug reactions
- Thermal

### **Immune Mediated/Autoimmune**

- Bullous pemphigoid
- Pemphigus foliaceus
- Toxic epidermal necrolysis/erythema multiforme

### **Miscellaneous/Idiopathic**

- Arthropod bites
- Dystrophic epidermolysis bullosa
- Eosinophilic plaque
- Idiopathic ulceration of dorsal neck
- Indolent ulcer
- Junctional epidermolysis bullosa
  - Skin fragility syndrome
  - Cutaneous asthenia (Ehler–Danlos syndrome)

## **Failure to Grow/Failure to Thrive**

### **Small Stature and Poor Body Condition**

Dietary insufficiency

Underfeeding

Poor-quality diet

GI disease

- Parasitism
- Inflammatory bowel disease
- Food intolerance/allergy
- Obstruction (foreign body, intussusception)
- Histoplasmosis

Hepatic dysfunction

- Portovascular anomaly
- Hepatitis
- Glycogen storage disease

Cardiac disorder

- Congenital anomaly
- Endocarditis

Pulmonary disease

Esophageal disease

- Megaesophagus
- Vascular ring anomaly (persistent right aortic arch)

Exocrine pancreatic insufficiency

Renal disease

Renal failure (congenital or acquired)

- Glomerular disease
- Pyelonephritis

Inflammatory disease

Glycogen storage disease

Hormonal disease

- Diabetes mellitus
- Hypoadrenocorticism
- Diabetes insipidus
- Juvenile hyperparathyroidism

### **Small Stature and Good Body Condition**

Chondrodystrophy

Hormonal disease

- Congenital hypothyroidism
- Congenital hyposomatotropism (pituitary dwarfism)
- Hyperadrenocorticism

# Fever of Unknown Origin

## Infection

### Bacterial

Abscessation (inapparent subcutaneous, stump pyometra, liver, pancreas, tooth root, retrobulbar)  
Pyelonephritis  
Diskospondylitis  
Osteomyelitis  
Pneumonia  
Prostatitis  
Peritonitis  
Pyothorax  
Closed pyometra  
Splenic abscess  
Septic arthritis  
Sepsis  
Cholangiohepatitis (cat)  
Bartonellosis  
*Mycoplasma haemofilis* (formerly *Hemobartonella felis*)  
Borreliosis  
Brucellosis  
Leptospirosis  
Mycobacteriosis 1-form bacteria (cat)  
Mycoplasmosis  
Salmonellosis  
Tularemia  
Bacterial endocarditis  
Plague  
Tuberculosis

### Fungal

Blastomycosis  
Histoplasmosis  
Coccidioidomycosis  
Cryptococcosis  
Systemic aspergillosis

### Viral

Canine distemper  
Canine influenza  
FIV  
FeLV  
FIP (*Coronavirus*)

### Rickettsial

Rocky Mountain spotted fever  
Ehrlichiosis  
Anaplasmosis  
Salmon poisoning

### Protozoal

Toxoplasmosis  
Babesiosis  
Hepatozoonosis

Cytauxzoonosis  
Trypanosomiasis (Chagas disease)  
Leishmaniasis  
Neosporosis

## Neoplasia

Lymphoma  
Multiple myeloma  
Leukemia  
Histiocytic sarcoma  
Necrotic solid tumors

## Immune Mediated

Polyarthritits  
Vasculitis  
Meningitis  
SLE  
Pemphigus  
Rheumatoid arthritis  
Immune-mediated hemolytic anemia  
Immune-mediated thrombocytopenia  
Meningoencephalitis (granulomatous, necrotizing)  
Steroid-responsive fever  
Steroid-responsive neutropenia

## Inflammatory

- Hypertrophic osteodystrophy
- Juvenile cellulitis
- Pancreatitis
- Panniculitis
- Panosteitis
- Pansteatitis

## Other

Hyperthyroidism  
Tissue damage  
Pharmacologic agents

- Tetracycline
- Penicillins
- Sulfas

Metabolic bone disease  
Portosystemic shunt  
Hypothalamic disease  
Shar-Pei fever  
Idiopathic

## Flatulence

Dietary intolerance (high-fiber, high-protein, or high-fat foods; high-sulfur diets; spoiled food; food change)

Maldigestion

- Exocrine pancreatic insufficiency
- Lactose intolerance

Malabsorption

Motility disorders (disrupt passage of gas)

Aerophagia

Behavior (aerophagia associated with competitive eating habits)

Various gastrointestinal disorders

## **Gagging**

### **Nutritional**

Food texture  
Food size

### **Infectious**

Viral encephalitis (rabies, pseudorabies)  
Fungal (focal, systemic)  
Bacterial encephalitis

### **Toxic**

Chemical (caustic chemicals, smoke)  
Botulism

### **Developmental**

Cleft palate  
Hydrocephalus  
Achalasia

### **Degenerative**

Laryngeal paralysis  
Muscular dystrophy  
Myasthenia gravis  
Neuropathy of cranial nerves V, VII, IX, or XII

### **Mechanical**

Foreign body  
Styloid disarticulation

### **Metabolic**

Uremia  
Hypocalcemia

### **Neoplasia**

Tonsils, pharynx, epiglottis, glottis, inner ear, nasal, central nervous system

### **Trauma**

Tracheal rupture  
Pharyngeal hematoma  
Medulla or pons ischemia or edema

### **Allergic or Immune Mediated**

Rhinitis  
Pharyngitis  
Laryngitis  
Asthma



Granuloma complex  
Idiopathic glossopharyngitis

## Genital Dermatoses

### Lesions of the Prepuce/Sheath

Bacterial folliculitis/furunculosis

Allergic dermatitis affecting the abdomen with hyperpigmentation/lichenification/hypertrophy of the sheath

Localized demodicosis

Vasculitis

Autoimmune skin diseases

Linear dermatosis of the prepuce (estrogen-secreting tumor)

Linear epidermal nevus

Vascular nevus

Various neoplasms (Stricker sarcoma, hemangiosarcoma, mast cell tumor)

### Lesions of the Scrotum

Contact dermatitis (most common scrotal skin disease)

Frostbite, solar erythema, trauma

Intertrigo

*Malassezia* dermatitis

Protothecosis

Babesiosis

Cuterebriasis

Brucellosis

Infection with *Erysipelothrix rhusiopathiae*

Rocky Mountain spotted fever

Superficial necrolytic dermatitis

Autoimmune diseases (bullous diseases, lupus)

Erythema multiforme

Fixed pigmented erythema

Cutaneous histiocytosis

Vascular hamartoma

Neoplasms (squamous cell carcinoma, apocrine adenocarcinoma, myxoma and fibrosarcoma, hemangioma, recurrent cystic hemangioma and hemangiosarcoma, plasmocytoma, lymphoma, histiocytoma, benign fibrous histiocytoma, mast cell tumor, melanoma)

### Female

Intertrigo

Allergic dermatitis affecting the abdomen with hyperpigmentation/lichenification/hypertrophy of the vulva

*Malassezia* dermatitis

Demodicosis

Bacterial furunculosis

Contact dermatitis

Autoimmune diseases (lupus, bullous diseases)

Endocrine disorders (especially hyperestrogenism)

Neoplasms

## Halitosis

### Oral Disease

Periodontal disease (gingivitis, periodontitis, abscessation)  
Calculus  
Food traps (periodontal pockets, exposed tooth roots, oral ulcers)  
Neoplasia (melanoma, fibrosarcoma, squamous cell carcinoma)  
Foreign body  
Trauma/fracture  
Electric cord injury  
Pharyngitis  
Stomatitis/glossitis

### Metabolic Disease

Renal failure (uremia)  
Diabetic ketoacidosis

### Gastrointestinal Disease

Megaesophagus  
Inflammatory bowel disease  
Exocrine pancreatic insufficiency  
Neoplasia  
Constipation

### Respiratory Disease

Rhinitis/sinusitis  
Neoplasia  
Pneumonia or pulmonary abscess

### Dermatologic Disease

Lip fold pyoderma  
Eosinophilic granuloma  
Ulcerative mucocutaneous pyoderma  
Pemphigus complex  
Bullous pemphigoid  
Lupus erythematosus  
Drug eruption  
Cutaneous lymphoma  
Exposure to dimethyl sulfoxide (DMSO)

### Dietary

Aromatic foods (onions, garlic)  
Fetid food (carrion)  
Coprophagy

### Grooming Behavior

Anal sacculitis  
Vaginitis/balanoposthitis  
Lower urinary tract infections  
Hair retained in periodontal pockets



## Head Tilt

### Peripheral Vestibular Disease

Otitis media/interna

Feline idiopathic vestibular disease

Geriatric canine vestibular disease

Feline nasopharyngeal polyps

Middle ear tumor

- Ceruminous gland adenocarcinoma
- Squamous cell carcinoma

Trauma

Aminoglycoside ototoxicity

Hypothyroidism (possibly)

Congenital (German Shepherd, Doberman Pinscher, English Cocker Spaniel, Siamese and Burmese cats)

### Central Vestibular Disease

Trauma/hemorrhage

Infectious inflammatory disease

- Rocky Mountain spotted fever
- FIP
- Bacterial
- Protozoal
- Mycotic
- Rickettsial
- Others

Granulomatous meningoencephalitis

Neoplasia (meningioma, choroid plexus tumors)

Vascular infarct

Thiamine deficiency

Metronidazole toxicity

Viral (canine distemper virus, FIP)

Toxic (lead, hexachlorophene)

Degenerative diseases (storage diseases, neuronopathies, demyelinating diseases)

Hydrocephalus

## Hematemesis

### Alimentary Tract Lesion

#### Gastritis

Acute gastritis (common cause)  
Hemorrhagic gastroenteritis  
Chronic gastritis  
*Helicobacter*-associated disease

#### Foreign Body

#### Heavy Metal Intoxication

Arsenic, lead, zinc

#### Gastrointestinal Tract Ulceration/Erosion

#### Iatrogenic

NSAIDs  
Corticosteroids  
NSAIDs used in combination with corticosteroids

#### Infiltrative Disease

Neoplasia  
Inflammatory bowel disease  
Pythiosis (young dogs, southeastern United States)  
Stress ulceration

- Hypovolemic shock
- Septic shock
- After gastric dilatation/volvulus
- Neurogenic shock

Burns  
Multiple trauma  
Hyperacidity

- Mast cell tumor
- Gastrinoma (rare)

Other causes

- Hepatic disease
- Renal disease
- Hypoadrenocorticism
- Inflammatory disease

#### Esophageal Disease (Uncommon)

Tumor  
Severe esophagitis  
Trauma

#### Bleeding Oral Lesion

#### Gallbladder Disease (Rare)

### Coagulopathy

Thrombocytopenia/platelet dysfunction  
Clotting factor deficiency

DIC  
Anticoagulant rodenticide

## **Extraalimentary Tract Lesion**

Respiratory tract lesion  
Lung lobe torsion  
Pulmonary tumor  
Posterior nares lesion

## Hematochezia

### Anal Disease

Perianal fistulas  
Anal sacculitis or abscess  
Stricture  
Neoplasia (perianal adenoma, anal sac adenocarcinoma)  
Anal trauma  
Perineal hernia  
Foreign body

### Rectal and Colonic Disease

Hemorrhagic gastroenteritis  
Proctitis  
Colitis

- Idiopathic
- Dietary allergy
- Inflammatory bowel disease
- Stress
- Infectious (*Campylobacter* spp., *Clostridium perfringens*)
- Histoplasmosis
- Pythiosis
- Food allergy
- Trichomoniasis (cat)

Parvovirus  
Parasites

- Whipworms
- Hookworms
- Coccidia

Neoplasia

- Rectal polyp
- Adenocarcinoma
- Lymphoma
- Leiomyoma or leiomyosarcoma

Prolapsed rectum  
Mucosal trauma

- Foreign body or foreign material
- Pelvic fractures
- Iatrogenic (thermometers, enemas, fecal loops, rectal palpation)

Iliocecal intussusceptions



# Hematuria

## Renal or Lower Urinary Tract Disease

Inflammation/infection  
Urolithiasis  
Obstruction  
Trauma (catheter collection, cystocentesis, renal biopsy, blunt trauma)  
Neoplasia  
Bleeding disorder (anticoagulant intoxication, DIC, thrombocytopenia)  
Heat stroke  
Renal infarct  
Granulomatous urethritis  
Feline lower urinary tract disease (FLUTD)  
Parasitism (*Diectophyma renale*, *Capillaria plica*)  
Drug induced (cyclophosphamide)  
Renal pelvic hematoma  
Vascular malformation  
Idiopathic renal hematuria  
Renal telangiectasia of Welsh Corgis  
Renal hematuria of Weimaraners  
Pseudohematuria (myoglobin, hemoglobin, drugs, dyes)

## Extraurinary Disease

Prostatic disease (infection, tumor, cyst, abscess)  
Uterine disease (pyometra, proestrus, tumor, subinvolution of placental sites)  
Vaginal (trauma, neoplasia)  
Estrus  
Preputial/penile (trauma, neoplasia)

# Hemoptysis

## Cardiovascular

Heartworm disease  
Cardiogenic pulmonary edema  
Arteriovenous fistula  
Bacterial endocarditis

## Pulmonary

Thromboembolism (secondary to neoplasia, endocrine, cardiac, metabolic disease)  
Bacterial pneumonia  
Pulmonary abscess  
Nocardiosis  
*Bordetella bronchiseptica* infection  
Chronic bronchitis/bronchiectasis  
Fungal pneumonia (blastomycosis, coccidiomycosis, histoplasmosis)  
Neoplasia (hemangiosarcoma, primary adenocarcinoma, undifferentiated carcinoma, squamous cell carcinoma, chondrosarcoma, metastatic or primary tracheal tumors)  
Lung lobe torsion  
Parasites (*Paragonimus kellicotti*, *Capillaria aerophila*, *Aelurostrongylus abstrusus*)  
Pulmonary infiltrate with eosinophils  
Systemic bleeding disorder

- Primary (quantitative or qualitative platelet defects)
- Secondary (factor deficiencies, anticoagulant rodenticide toxicity, DIC)

Trauma (pulmonary contusion, tracheal rupture, foreign body)  
Iatrogenic (endotracheal intubation, complication of lung biopsy/aspirate, transtracheal wash, bronchoscopy)

## Hemorrhage, Prolonged

See Part Two, Section V: Differential Diagnosis for Thrombocytopenia, [Platelet Dysfunction](#), and [Coagulopathies, Inherited and Acquired](#).

## Horner Syndrome

2.5% phenylephrine eye drops applied

### No Pupillary Dilation (Assume Preganglionic Lesion)

First order (central)

Intracranial disease (neoplasia, trauma, infarct)

First cervical to third thoracic (C1-T3) spinal myelopathy (intervertebral disc disease, neoplasia, fibrocartilaginous embolism, trauma)

Second order (preganglionic)

Spinal cord lesion T1-T3 (trauma, neoplasia, fibrocartilaginous embolism)

Thoracic disease (cranial mediastinal mass, thoracic spinal nerve root tumor)

Brachial plexus avulsion

Cervical soft tissue neoplasia, trauma

Skull base tumor

Jugular furrow disease

### Pupillary Dilation (Assume Postganglionic Lesion)

Third order (postganglionic)

FeLV, FIV

Otitis media/interna

Otic mass

Retrobulbar injury, neoplasia

Idiopathic

# Hyperemia

## Differential Diagnosis of Hyperemia

### Regional hyperemia

- Allergen exposure (contact, insect/mite bite)
- External constriction (rubber band, collar, identification band, tight bandage)
- Internal obstruction

### Generalized hyperemia

- Hyperthermia induced (infectious, inflammatory, immune mediated, neurogenic, environmental, toxic)
- Anaphylaxis/drug reaction
- Mast cell tumor
- Contact dermatitis
- Carbon monoxide intoxication
- Pheochromocytoma
- Decreased venous return (cardiac, hepatic, venous occlusion)

## Hyperpigmentation

Increased melanin in the epidermis

### Hereditary Hyperpigmentation

Lentigines—darkly pigmented macules that develop on the ventral abdomen of healthy adult dogs and on the lips, nose, gingiva, and eyelids of orange cats. No adverse health effects.

Canine acanthosis nigricans—bilateral hyperpigmentation and lichenification of axillary skin.

Primary, hereditary form seen in Dachshunds beginning before age 1. When seen in older Dachshunds or other breeds, it is likely a postinflammatory form seen with friction, intertrigo, allergies, or endocrine disease.

Acromelanism—dark areas on the points of Siamese, Himalayan-Persian, Balinese, and Burmese cats. Result of a temperature-dependent enzyme controlling melanin production in hair bulbs.

### Acquired Hyperpigmentation

Postinflammatory—Mediators of inflammation (e.g., leukotrienes, thromboxanes) stimulate melanocytes to increase melanin production, which down-regulates inflammation by scavenging free radicals. Examples of inflammatory conditions that lead to increased melanin production include allergies, *Malassezia* dermatitis, bacterial pyoderma, dermatophytosis, demodecosis, scabies, and actinic and intertrigo dermatitis. Inflammation affecting hair follicles may lead to melanotrichia (e.g., sebaceous adenitis, panniculitis, vaccine reactions).

Endocrine—hyperadrenocorticism, hypoadrenocorticism, hypothyroidism, hyperestrogenism, and other sex hormone imbalances may result in diffuse hyperpigmentation.

Papillomavirus associated—Pugs may be at risk for development of papillomavirus-associated, slightly raised, scaly, hyperpigmented macules and plaques in their groin region, abdomen, ventral thorax, and neck. Similar lesions are described in Miniature Schnauzers, American Staffordshire Terriers, and Pomeranians. May transform to squamous cell carcinoma.

Pigmented tumors—apocrine cysts are bluish, cutaneous hemangiomas and hemangiosarcomas appear red, dark purple, or bluish-black. Melanomas, melanocytomas, and basal cell tumors are frequently black. Squamous cell carcinomas, trichoblastomas, and fibromas also may be dark brown to black.

# Hyperthermia

## Fever

Exogenous pyrogens (infectious agents and their products, inflammation or necrosis of tissue, immune complexes, pharmacologic agents, bile acids)

Endogenous pyrogens (fever-producing cytokines)

## Heat Stroke

High ambient temperatures

Exercise

Poor ventilation

Brachycephalic conformation

Obesity

## Exercise Hyperthermia

Sustained exercise

Seizure disorders (especially prolonged or cluster seizures)

Hypocalcemic tetany (eclampsia)

## Pathologic Etiologies

Lesions in or around anterior hypothalamus

Hypermetabolic disorders

Hyperthyroidism

Pheochromocytoma

Malignant hyperthermia

Halothane

Succinylcholine

Phenothiazines

## Hypopigmentation

Due to melanocyte destruction, dysfunction, or abnormal distribution of melanosomes

### Hereditary Hypopigmentation

Albinism—hereditary absence of pigment

Piebaldism—presence of white spots where melanocytes are absent

Waardenburg–Klein syndrome—affected animals have absence of melanocytes in areas of skin and hair, blue or heterochromatic eyes, and are also deaf. Reported in cats, Bull Terriers, Sealyham Terriers, Collies, and Dalmatians.

Canine cyclic hematopoiesis—lethal autosomal-recessive disease of Collies. Gray coat, light-colored nose, cyclic episodes of neutropenia every 12-14 days resulting in sepsis and amyloidosis.

Chédiak–Higashi syndrome—rare autosomal-recessive disease of blue smoke Persian cats. Partial oculocutaneous albinism with abnormal function of granulocytes and platelets resulting in hemorrhage, recurrent infections, and death at a young age.

Graying—age-associated reduction of melanocyte replication

Vitiligo—macular leukoderma and leukotrichia of nose, ears, buccal mucosa, and facial skin.

Antimelanocyte antibodies found in serum of some affected dogs. Seen most commonly in Siamese cats, Belgian Tervuren, German Shepherd, Collie, Rottweiler, Doberman Pinscher, Giant Schnauzer.

Nasal hypopigmentation—season-associated lightening of nasal planum during winter months most common in Siberian Husky, Golden Retriever, Labrador Retriever, and Bernese Mountain Dog. Seen also in many other breeds.

Mucocutaneous hypopigmentation—leukoderma of the nasal planum, lips, eyelids, tongue, and oral cavity. Many breeds of dogs, but more common in Australian Shepherds, Siberian Huskies, Golden Retrievers, and Labrador Retrievers. Congenital condition in Rottweilers and Doberman Pinschers.

Tyrosinase deficiency—rare condition in Chow Chows. Puppies show dramatic color change, bluish-black tongue turns pink, hair shafts turn white. Melanin reappears spontaneously in 2-4 months.

### Acquired Hypopigmentation

Postinflammatory—DLE is the most common cause of postinflammatory nasal depigmentation.

Also pemphigus complex, SLE, uveodermatologic syndrome, bullous pemphigoid, mucocutaneous pyoderma, drug eruption, and contact dermatitis. Infectious causes include leishmaniasis, blastomycosis, sporotrichosis, and bacterial folliculitis.

Drug related—ketoconazole, procainamide, and vitamin E may cause diffuse coat lightening.

Nutritional/metabolic—deficiencies of zinc, pyridoxine, pantothenic acid, and lysine are associated with graying of hair. Dark hairs may become reddish in color with copper deficiency, hypothyroidism, hyperadrenocorticism, hyperestrogenism, hyperprogesteronism, chlorine exposure, and chronic exposure to ultraviolet light.

Neoplasia associated—nasal depigmentation, leukoderma, and leukotrichia sometimes seen with epitheliotropic T-cell lymphoma, basal cell tumors, mammary adenocarcinoma, and gastric carcinomas.

Idiopathic—leukotrichia and patchy hypopigmentation reported as idiopathic in Labrador Retrievers and black Newfoundlands. Siamese cats may be affected with periocular leukotrichia, which may be associated with upper respiratory tract infections, pregnancy, dietary deficiencies, or systemic illness.



# Hyphema

## Causes of Hyphema

### Genetic/breed predisposition

- Hereditary coagulopathies
- Breeds predisposed to retinal detachment
  1. Retinal dysplasia: presumed autosomal-recessive trait, (English Springer Spaniel, Bedlington Terrier, American Cocker Spaniel, Miniature Schnauzer); incomplete dominant inheritance in breeds with associated skeletal deformities (Labrador Retriever, Samoyed)
  2. Multifocal retinopathy: autosomal recessive in Coton de Tulear, Great Pyrenees, Australian Shepherd
  3. Collie eye anomaly (Collies, Shetland Sheepdog, Border Collie, Australian Shepherd)
  4. Shih Tzus are predisposed to vitreous degeneration and rhegmatogenous (retina is torn) retinal detachments
- Persistent hyperplastic primary vitreous in Doberman Pinschers

### Stimuli for intraocular neovascularization

- Retinal detachments
- Intraocular neoplasia
- Glaucoma
- Uveitis

### Predisposition to ocular trauma

- Blind animals
- Hunting dogs
- Exophthalmic animals
- Puppies exposed to cats

### Systemic diseases that cause vasculopathy and/or bleeding disorders

- Systemic hypertension
- Lymphoma
- Hyperviscosity syndromes (multiple myeloma, polycythemia vera)
- Infectious disease (feline leukemia virus, feline infectious peritonitis, rickettsial diseases)
- Immune-mediated thrombocytopenia or anemia
- Anticoagulation rodenticide intoxication

# Hypothermia

## Predisposing Factors

Anesthesia  
Low ambient temperature  
Neonate  
Small size  
Elderly  
Sick  
Debilitated  
Near drowning  
Enema

## Systemic Disease

- Cardiac disease
- Hypothyroidism
- Sepsis
- Chronic kidney disease
- Hypoadrenocorticism
- Malnourished
- Hypoglycemia
- Neurologic disease (head trauma, neoplasia, cerebral vascular disease)

## Icterus (Jaundice)

### Hemolysis

Autoimmune hemolytic anemia

Hemolytic anemia secondary to drugs, neoplasia

Infectious (*Ehrlichia canis*, *Babesia canis*, *Babesia felis*, *Mycoplasma hemocanis*, *Mycoplasma hemofelis*, *Cytauxzoon felis*, heartworm disease, FeLV)

Toxic (onions, lead, copper, methylene blue, benzocaine, propylene glycol, acetaminophen [cats], phenazopyridine)

Fragmentation (DIC, hemangiosarcoma, vena cava syndrome)

Erythrocyte membrane or enzyme defects (pyruvate kinase deficiency [Beagle, Basenji], phosphofructokinase deficiency [English Springer Spaniel], stomatocytosis of chondrodysplastic [Malamutes])

Congenital porphyria

Snake, brown recluse spider, and bee venoms

### Hepatobiliary Disease

Cholangiohepatitis

Chronic inflammatory hepatic disease

Cirrhosis

Diffuse neoplasia

Copper toxicity

Toxic hepatopathy (anticonvulsants, mebendazole, oxbendazole, diethylcarbamazine, inhalation anesthetics, thiacetarsamide, acetaminophen, trimethoprim-sulfa)

Hepatic lipidosis

FIP

Parasitic

Idiosyncratic drug reaction

### Posthepatic Biliary Obstruction

Pancreatitis

Enteritis/cholecystitis

Trauma

Neoplasia

Calculus

Stricture

Mucocele

Ruptured bile duct or gallbladder

# Inappropriate Elimination

## Dogs

### Medical Causes

#### Fecal House Soiling

Increased volume of feces (maldigestion, malabsorption, high-fiber diets)  
Increased frequency of voiding (colitis, diarrhea)  
Compromised neurologic function (peripheral nerve impairment, spinal cord disease, brain tumor, encephalitis, infection, degenerative brain disorders)  
Joint pain  
Sensory decline  
Cognitive dysfunction

#### Urinary House Soiling

Diseases causing polyuria (e.g., renal disease, hyperadrenocorticism, diabetes, pyometra)  
Increased urinary frequency (urinary tract infection/inflammation, urolithiasis, bladder tumors, prostatitis, abdominal masses)  
Impaired bladder control (peripheral nerve disease, spinal cord disease, brain tumor, encephalitis, infection, degenerative brain disorders)  
Urethral incompetence  
Anatomic problems  
Urethral sphincter mechanism incompetence (estrogen-responsive incontinence)  
Cognitive dysfunction

### Behavioral Causes

Inadequate training  
Submissive urination  
Excitement urination  
Marking  
Separation anxiety  
Management-related problems  
Location or surface preference

## Cats

### Medical Causes

#### Fecal House Soiling

Increased volume of feces (maldigestion, malabsorption, high-fiber diets)  
Increased frequency of voiding (colitis, diarrhea, inflammatory bowel disease)  
Compromised neurologic function (peripheral nerve impairment, spinal cord disease, brain tumor, encephalitis, infection, degenerative brain disorders)  
Joint pain  
Anal sacculitis  
Obstipation/constipation  
Hyperthyroidism  
Neoplasia  
Cognitive dysfunction

#### Urinary House Soiling

Diseases causing polyuria (e.g., renal disease, hyperadrenocorticism, diabetes, pyometra)  
Increased urinary frequency (FLUTD, urolithiasis, idiopathic cystitis)  
Impaired bladder control (peripheral nerve disease, spinal cord disease, brain tumor, encephalitis,

infection, degenerative brain disorders)  
Joint pain, disk disease  
Hyperthyroidism  
Neoplasia  
Anatomic problems  
Cognitive dysfunction

## **Behavioral Causes**

### **Litterbox Aversion**

Aversive disorder (deodorant, ammonia)  
Inadequate cleaning  
Discomfort during elimination (FLUTD, constipation, diarrhea, arthritis)  
Unacceptable litter (texture, depth, odor, plastic liner)  
Unacceptable box (too small, sides too high, covered)  
Disciplined, medicated, or frightened in box

### **Location Aversion**

Too much traffic  
Traumatic/fearful experience in area

### **Other**

Location preference  
Surface preference  
Anxiety (owner absence, high cat density, moving, new furniture, inappropriate punishment, teasing, household changes, remodeling in home)  
Need for privacy (other pets, anything that makes box less accessible to cat)

### **Urine Marking**

Hormones  
Temperament  
Feline population density  
Indirect signaling from other cats (scent on visitor's clothing)  
Changes in environment (new roommate, remodeling home, new furniture, and other novel items in home)  
Owner absence from home  
Lack of owner attention  
Inappropriate punishment

## **Incontinence, Fecal**

### **Nonneurologic Disease**

#### **Colorectal Disease**

Inflammatory bowel disease  
Neoplasia  
Constipation

#### **Anorectal Disease**

Perianal fistula  
Neoplasia  
Surgery (anal saccullectomy, perianal herniorrhaphy, rectal resection and anastomosis)

#### **Miscellaneous**

Decreased mentation  
Old age  
Severe diarrhea  
Irritable bowel disease

### **Neurologic Disease**

#### **Sacral Spinal Cord Disease**

Diskospondylitis  
Neoplasia  
Degenerative myelopathy  
Congenital vertebral malformation  
Sacrococcygeal hypoplasia of Manx cats  
Sacral fracture  
Sacrococcygeal subluxation  
Lumbosacral instability  
Meningomyelocele  
Viral meningomyelitis

#### **Peripheral Neuropathy**

Trauma  
Penetrating wounds  
Repair of perineal hernia  
Perineal urethrostomy  
Hypothyroidism  
Diabetes mellitus  
Dysautonomia

## Incontinence, Urinary

### Bladder Distended

#### Neurogenic

Lower motor neuron disease (sacral [S1-S3] segments or peripheral nerves)

Bladder easily expressed, dribbles urine

Detrusor areflexia with sphincter areflexia

Upper motor neuron disease

Bladder difficult to express; may be associated with paresis, paralysis

Detrusor areflexia with sphincter hypertonia

Dysautonomia

#### Obstructive

Reflex dyssynergia (functional obstruction)

Mechanical obstruction (uroliths, tumors, strictures, granulomatous urethritis, urethral inflammation, prostatic disease, mucoid or crystalline plug [feline])

### Bladder Not Distended

#### Dysuria/Pollakiuria Absent

Urethral sphincter mechanism incompetence (middle-aged to older spayed or neutered dogs)

Congenital (ectopic ureters, patent urachus)

#### Dysuria/Pollakiuria Present

Detrusor hyperreflexia/instability (uroliths, urinary tract infection, urethral mass)

## **Infertility, Female**

### **Normal Cycles**

Improper breeding management

Infertile male

Elevated diestrual progesterone

- Early embryonic death
- Lesions in tubular system (vagina, uterus, uterine tubes)
- Placental lesions (brucellosis, herpes infection)

Normal diestrual progesterone

- Cystic follicles (ovulation failure)

### **Abnormal Cycles**

#### **Abnormal Estrus**

##### **Will Not Copulate**

Not in estrus

Inexperience

Partner preference

Vaginal anomaly

Hypothyroidism?

##### **Prolonged Estrus**

Cystic follicles

Ovarian neoplasia

Exogenous estrogens

Prolonged proestrus

##### **Short Estrus**

Observation error

Geriatric

Split estrus

#### **Abnormal Interestrual Interval**

##### **Prolonged Interval**

Photoperiod (queen)

Pseudopregnant/pregnant (queen)

Normal breed variation

Glucocorticoids (bitch)

Geriatric

Luteal cysts

##### **Short Interval**

Normal (especially queen)

Ovulation failure (especially queen)

Corpus luteum failure

“Split heat” (bitch)

Exogenous drugs

### **Not Cycling**

Prepubertal



Ovariohysterectomy  
Estrus suppressants  
Silent heat  
Unobserved heat  
Photoperiod (queen)  
Intersex (bitch)  
Ovarian dysgenesis  
Hypothyroidism (possibly)  
Glucocorticoid excess  
Hypothalamic-pituitary disorder  
Geriatric  
Ovarian neoplasia  
Premature ovarian failure

## **Infertility, Male**

### **Inflammatory Ejaculate**

Prostatitis  
Orchitis  
Epididymitis

### **Azoospermia**

Sperm-rich fraction not collected  
Sperm not ejaculated

- Incomplete ejaculation
- Obstruction
- Prostate swelling

Sperm not produced

- Endocrine
- Testicular
- Metabolic

### **Abnormal Motility/Morphology**

Iatrogenic  
Prepubertal  
Poor ejaculation  
Long abstinence

### **Abnormal Libido**

Female not in estrus  
Behavioral  
Pain  
Geriatric

### **Normal Libido**

Improper stud management  
Infertile female

### **Normal Libido/Abnormal Mating Ability**

Orthopedic  
Neurologic  
Prostatic disease  
Penile problem  
Prepuce problem

## Joint Swelling

Trauma

Degenerative joint disease

Neoplasia

Inflammatory joint disease—**infectious**

- Septic (bacterial)
- Fungal arthritis
  - Blastomycosis
  - Coccidioidomycosis
  - Cryptococcosis
- Lyme borreliosis
- Rickettsial arthritis
- Leishmaniasis
- Anaplasmosis
- Mycoplasma
- Bacterial 1 form—associated arthritis (cats)
- Viral arthritis (calicivirus infection—kittens, canine distemper virus—dogs)

Inflammatory joint disease—**noninfectious**

- Nonerosive
  - Immune-mediated polyarthritis (idiopathic)
  - SLE
  - Breed-specific polyarthritis syndromes (Akita, Boxer, Weimaraners, Bernese Mountain Dog, German Shorthaired Pointer, Beagle, Shar-Pei)
  - Lymphocytic/plasmacytic synovitis
  - Drug reaction (e.g., trimethoprim-sulfadiazine in Doberman Pinschers)
  - Chronic infection causing secondary immune-mediated polyarthritis (bacterial, ehrlichiosis, anaplasmosis, Rocky Mountain spotted fever, Lyme borreliosis, heartworm disease)
- Erosive
  - Rheumatoid arthritis
  - Erosive polyarthritis of Greyhounds
  - Feline chronic progressive polyarthritis

# Lameness

## Orthopedic

### Trauma

Fracture  
Luxation, subluxation  
Toenail trauma  
Bone contusion

### Infectious

Osteomyelitis (bacterial, fungal)  
Bacterial cellulitis  
Septic arthritis  
Tick-borne polyarthritis

### Immune-Mediated Polyarthritis

### Degenerative

Degenerative joint disease  
Cranial cruciate disease  
Hip dysplasia  
Elbow dysplasia

### Developmental

Patellar luxation  
Osteochondrosis  
Panosteitis  
Hypertrophic osteodystrophy  
Avascular necrosis of femoral head  
Nonunited anconeal process  
Bone cysts  
Radial agenesis

### Metabolic

Panosteitis  
Hypertrophic osteodystrophy (HOD)  
Diabetic neuropathy

### Nutritional

Vitamin D deficiency (rickets)

### Neoplasia

Osteosarcoma, synovial cell sarcoma, soft tissue sarcoma/carcinoma  
Multiple myeloma  
Metastatic to bone

## Muscles

### Trauma

Contusion  
Strain  
Laceration  
Rupture

## **Inflammatory**

Canine idiopathic polymyositis  
Feline idiopathic polymyositis  
Dermatomyositis

## **Infectious**

Protozoal myositis

## **Tendons**

### **Trauma**

Laceration  
Severance  
Avulsion

## **Ligaments**

### **Trauma**

Rupture  
Tear  
Hyperextension

# Lymphadenopathy (Lymph Node Enlargement)

## Infiltrative Lymphadenopathies

### Neoplastic

Primary hemolymphatic (lymphoma, multiple myeloma, systemic mast cell disease, leukemias, malignant histiocytosis, lymphomatoid granulomatosis)

Metastatic neoplasia (carcinomas, sarcomas, malignant melanoma, mast cell tumors)

### Nonneoplastic

Eosinophilic granuloma complex

Nonneoplastic mast cell infiltration

## Proliferative and Inflammatory Lymphadenopathies

### Infectious

Bacterial

- Localized bacterial infection
- Septicemia
- Systemic infection (e.g., *Borrelia burgdorferi*, *Brucella canis*, *Yersinia pestis*, *Corynebacterium*, *Mycobacterium*, *Nocardia*, *Streptococcus*, *Actinomyces*, *Bartonella*, *Ehrlichia* spp.)
- Contagious streptococcal lymphadenopathy

Parasitic (toxoplasmosis, demodicosis, babesiosis, cytauxzoonosis, hepatozoonosis, leishmaniasis, trypanosomiasis, *Neospora caninum*)

Rickettsial (ehrlichiosis, Rocky Mountain spotted fever, anaplasmosis, salmon poisoning)

Viral (FIV, FeLV, FIP, canine viral enteritis, infectious canine hepatitis)

Fungal (blastomycosis, cryptococcosis, histoplasmosis, aspergillosis, coccidioidomycosis, phaeohyphomycosis, phycomycosis, sporotrichosis, others)

Algal (protothecosis) *Pneumocystis carinii*

### Noninfectious

Immune-mediated disorders

- SLE
- Rheumatoid arthritis
- Immune-mediated polyarthritis
- Juvenile cellulitis

Drug reactions

Localized inflammation

Postvaccinal

Dermatopathic lymphadenopathy

Idiopathic

- Distinctive peripheral lymph node hyperplasia
- Plexiform vascularization of lymph nodes

## Melena

### Ingested Blood

Oral lesions  
Nasopharyngeal lesions  
Pulmonary lesions  
Diet

### Parasitism

Hookworms, protozoa

### Neoplasia

Adenocarcinoma  
Lymphoma  
Leiomyoma or leiomyosarcoma  
Mast cell tumor  
Gastrinoma  
Nasal or oral tumor

### Upper Gastrointestinal Inflammation

Acute gastritis  
Gastroduodenal ulceration/erosion  
Hemorrhagic gastroenteritis  
Inflammatory bowel disease  
Foreign body  
Esophagitis

### Infection

*Campylobacter*  
*Clostridium perfringens*  
*Salmonella*  
*Parvovirus*  
*Neorickettsia helminthoeca* (salmon poisoning)  
*Histoplasma*  
*Pythium*  
*Helicobacter*

### Drugs

NSAIDs  
Glucocorticoids

### Miscellaneous

Pancreatitis  
Liver failure  
Renal failure  
Hypoadrenocorticism  
GI ischemia (shock, volvulus, intussusception)  
Arteriovenous fistula  
Polyps  
Coagulopathies (thrombocytopenia, factor deficiencies, rodenticide toxicity, DIC)





## Muscle Wasting

See [Cachexia and Muscle Wasting](#).

## Nasal Discharge

See [Sneezing and Nasal Discharge](#).

# Nystagmus

## Peripheral Vestibular Disease

Horizontal nystagmus; fast phase toward normal side; no change with varying head position

Otitis media/interna

Feline idiopathic vestibular disease

Canine geriatric vestibular disease

Neoplasia

Feline nasopharyngeal polyp in middle ear

Granuloma

Trauma (iatrogenic secondary to ear cleaning)

Ototoxic drugs

Neuropathy (hypothyroid, cranial nerve VIII disease)

Congenital (German Shepherd, English Cocker Spaniel, Doberman Pinscher, Smooth-Haired Fox Terrier, Siamese, Burmese, Tonkinese)

## Central Vestibular Disease

Horizontal, vertical, or rotary nystagmus; direction may change with varying head position

Trauma/hemorrhage

Infectious inflammatory disease

Viral (canine distemper virus, FIP)

Rickettsial (Rocky Mountain spotted fever, ehrlichiosis)

Fungal (cryptococcosis)

Toxoplasmosis

Neosporosis

Granulomatous meningoencephalitis

Neoplasia

Vascular infarct

Thiamine deficiency

Metronidazole toxicity

Toxic (lead, hexachlorophene)

Degenerative diseases (storage diseases, neuronopathies, demyelinating diseases)

Hydrocephalus

Anomaly (caudal occipital malformation syndrome in Cavalier King Charles Spaniels)

Head trauma

# Obesity

## Causes

Excessive feeding  
Malnutrition  
High-carbohydrate diet (especially cats)  
Lack of exercise  
Inactivity (indoor lifestyle, middle age)  
Neutering?  
Genetic predisposition  
Hypothyroidism  
Hyperadrenocorticism  
Hyperinsulinism  
Acromegaly  
Hypopituitarism  
Hypothalamic dysfunction  
Drugs (glucocorticoids, progestogens, phenobarbital, primidone)

## Health Risks

Degenerative joint disease  
Cruciate ligament disease  
Hip dysplasia  
Traumatic joint disease  
Intervertebral disk disease  
Dyspnea (Pickwickian syndrome)  
Heat intolerance  
Exercise intolerance  
Diabetes mellitus (insulin resistance)  
Hepatic lipidosis (cats)  
Pancreatitis  
Dystocia  
Urinary tract disease  
Skin fold dermatoses  
Increased anesthetic risk

## Oliguria

See [Anuria and Oliguria](#).

## Pallor

## Anemia

### Regenerative Anemia

Immune-mediated hemolytic anemia (extravascular, intravascular)

Erythrocytic parasites (*Bartonella*, *Babesia*, *Cytauxzoon* spp.)

Fragmentation (DIC, heartworm disease, hemangiosarcoma, vasculitis, hemolytic uremic syndrome, diabetes mellitus)

Pyruvate kinase deficiency

Phosphofructokinase deficiency

Feline porphyria

Copper toxicity

Neonatal isoerythrolysis

Oxidative injury (onions, acetaminophen, zinc, benzocaine, mothballs, phenazopyridine)

Blood loss (external blood loss, blood loss to a body cavity, coagulopathies, endoparasites, GI blood loss)

### Nonregenerative Anemia

Anemia of chronic disease

Anemia from renal failure

FeLV

Endocrine (mild anemia associated with hypoadrenocorticism, hypothyroidism)

Myeloaplasia/aplastic anemia (FeLV infection, ehrlichiosis, trimethoprim-sulfa, estrogen toxicity, phenylbutazone, chemotherapy, chloramphenicol)

Myelodysplasia

Myeloproliferative and lymphoproliferative disorders

Myelofibrosis

## Shock

### Cardiogenic

Decreased ventricular function

- Dilated cardiomyopathy
- Myocarditis
- Myocardial infarction

Compromised ventricular filling

- Hypertrophic cardiomyopathy
- Cardiac tamponade

Severe endocardiosis

Outflow obstruction

- Intracardiac tumors
- Aortic stenosis
- Hypertrophic obstructive cardiomyopathy
- Heartworm disease
- Thrombosis
- Severe arrhythmia

### Noncardiogenic

Trauma

Hypovolemia

- Severe blood loss
- Dehydration
- Hypoadrenocorticism

Disruptions in blood flow

- Sepsis and endotoxemia
- Hypotension

## Panting

### Differential Diagnosis of Panting

- Elevated ambient temperature
- Exercise-induced hyperthermia
- Excessive/matted coat
- Obesity
- Fever
- Pain
- Anxiety/nervousness
- Glucocorticoid therapy
- Hyperadrenocorticism
- Hyperthyroidism
- Cardiac disease, tachyarrhythmia
- Feline bronchial disease
- Narcotic administration
- Hypocalcemia
- Pheochromocytoma
- Brain disease



## Papules and Pustules

- Bacterial pyoderma (papules and pustules)
- Demodicosis (papules and pustules)
- Dermatophytosis (rare papules, uncommon pustules)
- Sarcoptes mange (papules, no pustules)
- Cheyletiellosis (rare papules, no pustules)
- Otacariosis (rare papules, no pustules)
- Trombiculosis (papules, rare pustules)
- Hypersensitivity (papules, rare pustules)
- Pemphigus (papules and pustules)
- Early-stage neoplasia (papules, no pustules)

# Paresis and Paralysis

## Upper Motor Neuron

Tetraparesis or hemiparesis

- Severe forebrain lesion
- Brain stem lesion
- First to fifth cervical (C1-C5) spinal lesion

Paraparesis or rear limb monoparesis

- Third thoracic to third lumbar (T3-L3) spinal lesion

## Lower Motor Neuron

Tetraparesis

Generalized lower motor neuron disease

- Flaccid paresis/paralysis
  - Acute polyradiculoneuritis/“coonhound paralysis”
  - Tick paralysis
  - Botulism
  - Myasthenia gravis
- Toxicants
  - Coral snake
  - Black widow spider
  - Herbicides (2,4 D)
  - Macadamia nuts

Paraparesis

- Fourth lumbar to second sacral (L4-S2) spinal lesion

Hemiparesis with lower motor neuron forelimb

- Sixth cervical to second thoracic (C6-T2) spinal lesion

Aortic thromboembolism

Degenerative myelopathy

Monoparesis

Peripheral nerve lesion

# **Petechiae and Ecchymoses**

## **Thrombocytopenia**

### **Increased Platelet Destruction**

Immune-mediated thrombocytopenia  
SLE  
Heartworm disease

### **Decreased Platelet Production**

#### **Bone Marrow Suppression**

Infectious disease (ehrlichiosis, babesiosis, Rocky Mountain spotted fever, leishmaniasis, FeLV, FIV)  
Neoplasia  
Drug reactions  
Myeloproliferative disease  
Virus-associated myelodysplasia  
Estrogen toxicity

### **Consumption of Platelets**

DIC  
Vasculitis

### **Sequestration of Platelets (Unlikely to Cause Clinical Signs)**

Splenomegaly  
Hepatomegaly  
Endotoxemia

## **Thrombopathia**

### **Inherited**

Cocker Spaniel, Otterhound, Great Pyrenees, Bassett Hound, American Cocker Spaniel, cats

### **Acquired**

Drugs (aspirin, cephalothin, carprofen, hydroxyethyl starch)  
Uremia  
Liver disease  
Dysproteinemias

### **Von Willebrand Disease**

Lack of von Willebrand factor leads to impaired platelet adhesion.

## **Vascular Purpura**

Vasculitis secondary to infectious, inflammatory, immune-mediated, neoplasia, drug reaction, hyperadrenocorticism

## Pollakiuria

See [Stranguria, Dysuria, and Pollakiuria](#).

# Polyphagia

## Primary Polyphagia

- Destruction of satiety center (mass lesion, trauma, infection/inflammation)
- Psychogenic/gluttony
- Stress
- Introduction of more palatable diet

## Secondary Polyphagia

- Physiologically increased metabolic rate (cold temperature, pregnancy, lactation, growth, exercise)
- Pathologically increased metabolic rate (hyperthyroidism, infection, neoplasia)
- Decreased energy supply (diabetes mellitus, exocrine pancreatic insufficiency, infiltrative bowel disease, parasites, lymphangiectasia)
- Decreased intake (low-calorie diet, hypoglycemia, megaesophagus)
- Unknown (hyperadrenocorticism, portosystemic shunt/hepatoencephalopathy, sudden acquired retinal degeneration syndrome [SARDS])

## Drug-induced Polyphagia

- Glucocorticoids, phenobarbital, antihistamines, progestins, benzodiazepines, cyproheptadine, mirtazapine)

## Polyuria and Polydipsia

Renal insufficiency or failure

Diabetes mellitus

Hyperadrenocorticism (Cushing syndrome)

Lower urinary tract disease

- Infection
- Urolithiasis
- Neoplasia
- Anatomic problem
- Neurologic problem

Pyometra

Hypercalcemia

Hypoadrenocorticism (Addison disease)

Pyelonephritis

Hypokalemia

Iatrogenic (corticosteroids, diuretics, anticonvulsants)

Hyperthyroidism

Hepatic insufficiency

Postobstructive

Diabetes insipidus

- Central
- Renal

Psychogenic drinking

Renal glycosuria

## **Preputial Discharge**

### **Mucopurulent**

- Balanoposthitis
- Prostatitis
- Penile neoplasia
- Foreign body

### **Serosanguinous**

- Benign prostatic hyperplasia
- Balanoposthitis
- Prostatitis
- Urethral prolapse
- Penile/urethral trauma
- Penile/urethral uroliths
- Penile neoplasia
- Hemorrhagic diathesis
- Foreign body

## Pruritus

### Allergy

Flea allergy  
Atopic dermatitis  
Food allergy/intolerance  
Contact dermatitis  
Mosquito-bite hypersensitivity  
Eosinophilic plaque (cats)

### Parasites

Flea infestation  
Scabies  
Pediculosis (lice)  
Cheyletiellosis  
Chiggers  
Cutaneous larval migrans  
Demodicosis (often not pruritic)  
Otodectic acariasis  
Notoedres acariasis

### Infectious Agents

Pyoderma  
*Malassezia* dermatitis  
Dermatophytosis

### Behavioral

Acral lick dermatosis  
Psychogenic alopecia

### Immune Mediated

Pemphigus foliaceus

### Drug Eruption

### Miscellaneous

Cornification defects  
Superficial necrolytic dermatitis  
Tail dock neuroma  
Rhabditic dermatitis



## **Ptyalism (Excessive Salivation)**

### **Oral Cavity Disease**

Oral trauma (tooth fractures, mandibular fractures, maxillary fractures, temporomandibular joint [TMJ] luxation)

Severe periodontal disease

Oral masses (neoplasia, granuloma, eosinophilic granuloma)

Abscesses

Stomatitis (toxins, infections, immune-mediated disease, immunologic or nutritional deficiency)

Glossitis (chemical or environmental irritants, viral infections, uremia, immune-mediated disease, tumors)

Faucitis (cats)

Mucocutaneous junction lesions

Foreign body

Developmental (severe brachygnathism, lip fold pyoderma)

Conformational drooling

### **Oral Cavity Normal**

Drugs and toxins (bitter taste; insecticides such as organophosphates, pyrethrins, and  $\alpha$ -limonene; caustic chemicals; poison toads and salamanders)

Nausea

Hepatic encephalopathy/portosystemic shunt

Seizures

Space-occupying lesions in pharynx

Cranial nerve (CN) deficits (CN V: inability to close mouth; CN VII: inability to move lip; CNs X, XI, and XII: loss of gag lesion and inability to swallow)

Neuromuscular (myasthenia gravis, temporal or masseter muscle atrophy, tetanus)

Rabies virus

Dysphagia

Behavior (associated with food [Pavlovian], contentment/mood in cats when purring, pain)

Salivary gland hypersecretion

## Pulse Abnormalities

- Hyperkinetic pulse
  1. Anemia
  2. Hyperthyroidism
  3. Increased sympathetic tone
  4. Bradyarrhythmias
  5. Aortic insufficiency
  6. Patent ductus arteriosus
  7. Pregnancy
  8. Aorticopulmonary window
  9. Arteriovenous fistula/anastomosis
- Hypokinetic pulse
  1. Hypovolemia
  2. Reduced systolic function
  3. Aortic/subaortic stenosis
  4. Dynamic left ventricular outflow tract obstruction
- Decrease in pulse volume with inspiration
  1. Pericardial effusion with cardiac tamponade
  2. Exaggerated variation in intrapleural pressure (airway obstruction)
- Pulse deficits
  1. Atrial fibrillation
  2. Atrial/supraventricular premature complexes
  3. Ventricular premature complexes
  4. Pulsus alternans (alternating normal pulse and pulse deficits with myocardial failure)
- Irregular pulse rhythm
  1. Sinus arrhythmia (slow)
  2. Atrial fibrillation
  3. Atrial/supraventricular premature complexes (rapid)
  4. Ventricular premature complexes (rapid)
  5. Second-degree atrioventricular block (slow)
- Regional pulse variation
  1. Arterial thromboembolism

## Regurgitation

### Esophageal Disease

Megaesophagus (primary or secondary)

Esophagitis

Mechanical obstruction (foreign body, vascular ring anomaly, stricture)

### Alimentary Disorders

Pyloric outflow obstruction

Gastric dilatation/volvulus

Hiatal hernia

### Neuropathies

Peripheral neuropathy (polyradiculitis, polyneuritis, lead poisoning, giant cell axonal neuropathy)

Central nervous system (brain stem lesion, neoplastic, traumatic, distemper)

Dysautonomia

### Neuromuscular Junction Abnormalities

Myasthenia gravis (focal or generalized)

Tetanus

Botulism

Acetylcholinesterase toxicity

### Immune-Mediated Disorders

SLE

Polymyositis

Dermatomyositis

### Endocrine Disease

Hypothyroidism

Hypoadrenocorticism

### Infectious

Spirocercosis

*Pythium insidiosum*

# Restlessness

## Causes of Restless Behaviors in Dogs and Cats

### Normal behavior

- Discomfort from pollakiuria or tenesmus
- Periparturient
- Estrous
- Pseudopregnancy

### Emotional distress

- Fear/phobia
- Stress from altered environment or blindness
- Pending natural calamity (e.g., earthquake)
- Anxiety

### Pain

### Physiologic distress

- Shock
- Transfusion reaction
- Anaphylaxis
- Iatrogenic overhydration
- Dyspnea
- Pheochromocytoma
- Overheating
- Fever
- Pruritus

### Intoxication

- Drug induced (antipsychotics, tricyclic antidepressants, selective serotonin reuptake inhibitors, methylxanthines, sympathomimetics, prostaglandins, opioids, metoclopramide, antihistamines [cats], digoxin, salicylates, benzodiazepines [excitatory phase], drug or anesthesia induced dysphoria)
- Other toxic substances (metaldehyde, pyrethrins, strychnine, nicotine, organophosphates/carbamates, recreational drugs [amphetamine, cocaine], mycotoxins)

### Altered mentation/encephalopathy

- Primary central nervous system (CNS) disease (epileptic aura [preictal], tumors, inflammation, rabies/pseudorabies, geriatric cognitive dysfunction)
- Metabolic encephalopathies (hepatic encephalopathy, hypoglycemia, hypocalcemia)

### Increased metabolic rate

- Hyperthyroidism (iatrogenic or spontaneous)

## Reverse Sneezing

- Loud inspiratory noise, occurs in paroxysms; initiated by nasopharyngeal irritation
- Purpose is to move secretions and foreign material into the oropharynx to be swallowed
- Causes include excitement, foreign bodies, nasal mites (*Pneumonyssus caninum*), viral infections, and epiglottic entrapment of the soft palate
- Often idiopathic, nonprogressive, and common in small dogs and cats

## Scaling and Crusting

### Bacterial

Superficial folliculitis  
Deep pyoderma  
Mucocutaneous pyoderma  
Pyotraumatic dermatitis

### Fungal

Dermatophytosis  
*Malassezia* dermatitis  
Deep fungal infection (e.g., blastomycosis, cryptococcosis)

### Parasitic

Fleas  
Scabies  
Demodecosis  
Cheyletiellosis  
Notoedric mange  
Pediculosis

### Protozoal

Leishmaniasis

### Viral

FeLV

### Allergic

Atopic dermatitis  
Food hypersensitivity  
Flea-bite hypersensitivity  
Military dermatitis

### Endocrine and Metabolic

Hyperadrenocorticism  
Hypothyroidism  
Necrolytic migratory erythema

### Immune Mediated

Pemphigus foliaceus  
DLE  
Erythema multiforme

### Congenital and Hereditary

Primary seborrhea  
Ichthyosis  
Schnauzer comedo syndrome  
Familial canine dermatomyositis

## **Keratinization Defects**

Secondary seborrhea  
Vitamin A-responsive dermatosis  
Ear margin dermatosis

## **Environmental**

Solar dermatitis

## **Nutritional**

Zinc-responsive dermatosis  
Fatty acid deficiency

## **Other**

Cutaneous lymphoma  
Sebaceous adenitis  
Otitis externa

## Seizure

### Extracranial Causes

Toxins (e.g., strychnine, chlorinated hydrocarbons, organophosphates, carbamates, lead, ethylene glycol, metaldehyde)

Metabolic disease (e.g., hepatic encephalopathy, hypoglycemia, hypocalcemia)

Hepatic disease

Electrolyte disturbances (e.g., hypernatremia)

Severe uremia

Hyperlipoproteinemia

Hyperviscosity (multiple myeloma, polycythemia)

Hyperosmolality (diabetes mellitus)

Heat stroke

Hypertension

Hyperthyroidism (cats)

Hypothyroidism (dogs)

### Intracranial Causes

See **Part Two, Section XI: Differential Diagnosis for Inflammatory Disease of the Nervous System.**

Infectious disease

Neoplasia (primary brain tumor, lymphoma, metastatic tumors)

Granulomatous meningoencephalitis

Hemorrhage/infarct (renal failure, hypothyroidism, hyperthyroidism, hypertension, septic emboli, neoplasia, coagulopathies, heartworm disease, vasculitis)

Congenital malformations (lissencephaly, hydrocephalus)

Necrotizing meningoencephalitis, necrotizing leukoencephalitis

Degenerative diseases (metabolic storage diseases, leukodystrophies, hypomyelination disorders, spongy disorders)

### Idiopathic Epilepsy (Primary Epileptic Seizures) Epilepsy



# Sneezing and Nasal Discharge

## Nasal and Upper Respiratory Disease

### Infectious

Viral: feline herpesvirus, calicivirus, canine distemper virus

Bacterial: *Mycoplasma* spp., *Bordetella bronchiseptica*

Fungal: *Aspergillus*, *Cryptococcus*, *Rhinosporidium*, *Penicillium* spp.

Parasitic: *Pneumonyssus caninum* (nasal mite), *Eucoleus boehmi* (formerly *Capillaria* spp.), *Cuterebra* spp., *Linguatula* spp.

### Inflammatory

Allergic rhinitis

Lymphocytic-plasmacytic rhinitis

Acquired nasopharyngeal stenosis

Nasopharyngeal polyps

Polypoid rhinitis

### Neoplasia

Adenocarcinoma, squamous cell carcinoma

Fibrosarcoma, osteosarcoma, chondrosarcoma

Lymphoma, transmissible venereal tumor, neuroendocrine carcinoma

### Foreign Body

### Congenital

Cleft palate

Ciliary dyskinesia

Nasopharyngeal stenosis

Choanal atresia

### Dental Disease

Tooth root abscess

Oronasal fistula

### Trauma

### Vascular malformation

## Systemic Disease

### Infectious

Canine distemper virus

Canine infectious tracheobronchitis

Pneumonia

### Hypertension

Hyperthyroidism

Hyperadrenocorticism

Renal disease

Pheochromocytoma

Hypothyroidism

Acromegaly

Polycythemia

Diabetes mellitus  
Overhydration

### **Coagulopathies**

Thrombocytopenia  
Rocky Mountain spotted fever  
Thrombocytopathia  
von Willebrand disease  
Factor deficiencies  
Congenital (hemophilia A, B, others)  
Acquired (vitamin K rodenticide toxicity, DIC, hepatic failure)

### **Vasculitis**

Toxic  
Inflammatory  
Immune mediated (SLE)  
Neoplastic  
Infectious (ehrlichiosis, FIP, Rocky Mountain spotted fever, leishmaniasis)

### **Hyperviscosity**

Multiple myeloma  
Lymphoma  
IgM (Waldenstrom) macroglobulinemia  
Chronic lymphocytic leukemia  
Ehrlichiosis  
Amyloidosis  
Plasma cell leukemia  
FIP (rare)

## **Stertor and Stridor**

### **Stertor**

Snoring or snorting associated with partial nasal or nasopharyngeal obstruction

#### **Intranasal Disorders**

- Congenital deformities
- Masses
- Exudates
- Clotted blood

#### **Pharyngeal Disease**

- Brachycephalic airway syndrome
- Elongated soft palate
- Nasopharyngeal polyp
- Foreign body
- Neoplasia
- Abscess
- Granuloma
- Extraluminal mass

### **Stridor**

High-pitched wheeze caused by air turbulence in upper airway associated with laryngeal disease or narrowing of extrathoracic trachea

#### **Laryngeal Disease**

- Neoplasia
- Polyyps (nasopharyngeal)
- Laryngeal paralysis
- Laryngeal trauma
- Foreign body
- Acute laryngitis/obstructive laryngitis
- Brachycephalic syndrome
- Rhinitis
- Coagulopathy

#### **Extrathoracic Tracheal Disease**

- Neoplasia
- Foreign body
- Extrathoracic collapsing trachea
- Extraluminal mass

# Stranguria, Dysuria, and Pollakiuria

## Stranguria/Pollakiuria

### Small Bladder

Cystitis

- Infectious agents
- Idiopathic cystitis (cats)
- Chemically induced cystitis (cyclophosphamide)
- Polypoid cystitis

Detrusor hyperspasticity

Urethritis

Urethral mass

### Large Bladder

Lower urinary tract obstruction

- Functional
- Mechanical

## Urinary Retention

### Easy Catheterization

#### Normal Neurologic Examination

Cystic calculi or mass

Detrusor areflexia from overdistension

Reflex dyssynergia

#### Abnormal Neurologic Examination

Detrusor areflexia with sphincter areflexia (lower motor neuron)

Detrusor areflexia with sphincter hypertonia (upper motor neuron)

Dysautonomia

### Difficult Catheterization

Urethral spasm

Urethral calculi

Urethral stricture

Urethral neoplasia

Transitional cell carcinoma

Granulomatous urethritis

Urethral inflammation

Prostatic disease

Mucoid or crystalline plug (cats)

## Stomatitis

### Infectious disease

- FIV
- FeLV
- Feline syncytium-forming virus
- Feline calicivirus
- Feline herpesvirus
- FIP
- Bartonellosis
- Canine distemper virus
- Feline panleukopenia virus
- Candidiasis

### Immunosuppressive disease

Feline eosinophilic granuloma complex

Idiopathic feline chronic gingivitis/stomatitis

### Immune-mediated disease

- SLE
- Bullous (pemphigus) disease
- Idiopathic vasculitis
- Toxic epidermal necrolysis
- Ulcerative gingivitis/stomatitis of Maltese Terriers
- Sjögren-like syndrome

Uremic stomatitis

Radiation-induced

## Stunted Growth

### Small Stature and Poor Body Condition

- Nutritional (poor quality feed, underfeeding)
- Gastrointestinal (parasitism, food intolerance/allergy, inflammatory bowel disease, exocrine pancreatic insufficiency, obstruction)
- Esophageal disease (congenital myasthenia gravis, megaesophagus, vascular ring anomaly most commonly persistent right aortic arch)
- Cardiac (dog: most commonly subaortic stenosis, patent ductus arteriosus, pulmonic stenosis) (cat: most commonly ventricular septal defect, atrioventricular valve dysplasia)
- Systemic disease (metabolic/infectious: kidney disease, liver disease like portal systemic shunt, glycogen storage disease, respiratory infections like bacterial pneumonia, gastrointestinal infections)
- Endocrine (diabetes mellitus, hypoadrenocorticism, diabetes insipidus, juvenile hypoparathyroidism)

### Small Stature and Good Body Condition

- Bone growth (osteochondrodysplasia: disproportionate dwarfism)
- Endocrine
  1. Disproportionate dwarfism: congenital hypothyroidism
  2. Proportionate dwarfism: hyposomatotropism (growth hormone deficiency), hyperadrenocorticism (rare)

# **Stupor and Coma**

## **Increased Intracranial Pressure**

Encephalitis  
Meningitis  
Neoplasia  
Granulomas  
Abscess  
Vascular events (hemorrhage, embolism, ischemia)  
Trauma  
Underlying metabolic injury (e.g., hypertension)  
Developmental (hydrocephalus, storage diseases)

## **Systemic Infections**

Rabies  
FIP  
Canine distemper  
Fungal  
Parasitic

## **Cerebral Edema**

Vasogenic (brain masses that lead to breakdown of blood–brain barrier)  
Cytotoxic (hypoxia, neuroglycopenia)  
Interstitial (hydrocephalus)

## **Herniation of Brain Tissue**

Caudal transtentorial herniation  
Foramen magnum herniation

## **Extracranial Causes**

Hypoglycemia  
Hypernatremia  
Hyponatremia  
Diabetic ketoacidosis  
Uremic encephalopathy  
Severe hypothyroidism (myxedema coma)  
Heat stroke  
Toxins  
Hepatic disease  
Hyperadrenocorticism  
Erythrocytosis  
Hyperglobulinemia

# Syncope

## Normal Cerebral Perfusion

Severe hypoxemia  
Hypoglycemia

## Cerebral Hypoperfusion

### Normotension

Cerebrovascular disease  
Cerebral vasoconstriction

### Systemic Hypotension

### Decreased Cardiac Output

#### Loss of preload

Cardiac tamponade, atrial ball thrombi, atrial myxoma, atrioventricular (AV) valve stenosis, hypovolemia, diuretics

#### Obstruction to flow

Aortic and subaortic stenosis, pulmonic stenosis, pulmonary hypertension, pulmonary thromboembolism, outflow tract tumors, myocardial infarction, hypertrophic and restrictive cardiomyopathy, systolic anterior motion of mitral valve, infundibular stenosis, heartworm disease, masses obstructing flow

#### Arrhythmias

Bradyarrhythmias: sick sinus syndrome, third-degree AV block, persistent atrial standstill,  $\beta$ -blockers, calcium channel blockers

Tachyarrhythmias: atrial fibrillation, atrial tachycardia, AV reentrant tachycardia, ventricular tachycardia, drug-induced proarrhythmia, torsades de pointes

#### Loss of vascular resistance

Drug therapy: angiotensin-converting enzyme (ACE) inhibitors,  $\beta$ -blockers, calcium channel blockers, hydralazine, nitrates, phenothiazines

Reflex syncope (neurally mediated): orthostatic, postexertion, micturition, defecation, cough, emotional distress, pain, carotid sinus hypersensitivity

Autonomic nervous system disease: primary or secondary (diabetes mellitus, paraneoplastic, chronic renal failure, autoimmune disease, amyloidosis)

Cyanotic heart disease (tetralogy of Fallot, reversed shunt)



## Tachycardia, Sinus

Anxiety/fear  
Excitement  
Exercise pain  
Hyperthyroidism  
Heart failure  
Hyperthermia/fever  
Anemia  
Hypoxia  
Shock  
Hypotension  
Sepsis  
Drugs (anticholinergics, sympathomimetics)  
Toxicity (e.g., chocolate, amphetamines, theophylline)  
Electric shock  
Any cause of high sympathetic tone

## **Tenesmus and Dyschezia**

### **Colonic or Rectal Obstruction**

- Constipation
- Pelvic fracture
- Rectal neoplasia
- Anal sac neoplasia
- Extraluminal neoplasia
- Prostatomegaly
- Perineal hernia
- Pelvic canal mass
- Rectal granuloma
- Rectal foreign body
- Rectal stricture
- Perianal gland tumors
- Pseudocoprostasis

### **Perineal Inflammation or Pain**

- Anal sacculitis
- Perianal fistula
- Perianal abscess/abscessed anal sac

### **Rectal Inflammation or Pain**

- Rectal tumor/polyp
- Proctitis
- Histoplasmosis
- Pythiosis

### **Colonic Inflammation**

- Idiopathic colitis
- Bacteria
- Fungal
- Parasites
- Dietary indiscretion
- Inflammatory bowel disease
- Neoplasia

# Tremor

## Physiologic Tremor

Hypothermia (shiver)

Heavy exercise/exhaustion

## Pathologic Tremor

Metabolic disorders (renal disease, hypoglycemia, hypocalcemia, hypoadrenocorticism)

Intracranial infectious disease (*Neospora caninum*, cerebellar hypoplasia secondary to intrauterine panleukopenia infection)

Intracranial disease (fibrinoid leukodystrophy, neuraxonal dystrophy, Labrador Retriever axonopathy, spongiform encephalopathy, neuronal abiotrophies, subacute necrotizing encephalopathy, lysosomal storage diseases)

Hind end tremor (intervertebral disk herniation, tumors, diskospondylitis, nerve root compression, peripheral neuropathies)

Corticoid-responsive tremor syndrome (formerly “white shaker disease”)

Myasthenia gravis

Cerebellar malformation

Hypomyelination

Spongy degeneration

Tremorgenic toxins (mycotoxins penitrem A and roquefortine produced by *Penicillium* spp. growing on spoiled foods; metaldehyde, hexachlorophene, bromethalin, organophosphates, carbamates, pyrethroids, xanthines, macadamia nuts, strychnine)

Idiopathic head tremor in Doberman Pinschers and Bulldogs

Idiopathic tremor of hind legs of geriatric dogs

## **Urine, Discolored**

### **Red, Pink, Red-Brown, Red-Orange, or Orange**

Hematuria  
Hemoglobinuria  
Myoglobinuria  
Porphyrinuria  
Pyuria

### **Orange-Yellow**

Highly concentrated urine  
Urobilin  
Bilirubin

### **Yellow-Brown or Green-Brown**

Bile pigments

### **Brown to Black**

Melanin  
Methemoglobin  
Myoglobin  
Bile pigments

### **Brown**

Methemoglobin  
Melanin

### **Colorless**

Dilute urine

### **Milky White**

Lipid  
Pyuria  
Crystals

### **Pale Yellow**

Normal  
Dilute urine

## **Urticaria/Angioedema**

### **Immediate Hypersensitivity Reaction**

Insect bites/stings

Food

Drugs/vaccines

Airborne allergens (atopy)

### **Nonimmunologic Stimulus by Irritant**

Weeds

Insects

Physical stimuli (cold, heat, sunlight)

Psychogenic stimuli

## Vision Loss, Sudden

See [Blindness](#).

## Vomiting

### Gastric Disease

- Gastritis
- Parasites
- Foreign body
- Obstruction
- Ulceration
- Neoplasia
- Dilatation/volvulus
- Helicobacter* infection
- Gastric ulcer
- Hiatal hernia
- Motility disorders
- Pyloric stenosis
- Gastric antral mucosal hypertrophy

### Small Intestinal Disease

- Parasites
- Inflammatory bowel disease
- Foreign body
- Bacterial overgrowth/enteritis
- Hemorrhagic gastroenteritis
- Neoplasia
- Viral enteritis (parvovirus, canine distemper virus)
- Intussusception
- Nonneoplastic infiltrative disease (e.g., pythiosis)

### Large Intestinal Disease

- Colitis
- Obstipation
- Parasites

### Dietary

- Indiscretion
- Intolerance
- Allergy

### Drugs

- Cancer chemotherapeutic agents
- Antibiotics (especially erythromycin, tetracycline)
- NSAIDs
- Cardiac glycosides
- Apomorphine
- Xylazine
- Penicillamine

### Extraalimentary Tract Disease

- Peritonitis
- Pancreatitis
- Hepatobiliary disease

Neoplasia  
Uremia  
Diabetes mellitus/ketoacidosis  
Hypercalcemia  
Hyperthyroidism  
Hypoadrenocorticism  
Hepatic disease  
Hepatic encephalopathy  
Septicemia/endotoxemia  
Pyometra  
Acid–base disorders  
Electrolyte disorders  
Hypertriglyceridemia  
Gastrinoma (Zollinger–Ellison syndrome)  
Mastocytosis  
Motion sickness

## **Intoxicants**

Numerous inorganic, organic, and plant toxins can cause GI irritation and vomiting.

## **Neurologic Disease**

Epilepsy, tumor, meningitis, increased intracranial pressure, dysautonomia



## Vulvar Discharge

### Serosanguinous Vaginal Discharge

#### Intact

- Physiologic estrogen influence (proestrus)
- Prolonged estrogen duration (ovarian neoplasia, cystic ovarian follicles, failure to ovulate, exogenous estrogen, portosystemic shunt, pituitary hypofunction)
- Absence of estrogen influence (endometriosis, neoplasia of urogenital tract, subinvolution of placental sites, trauma, hemorrhagic diathesis, vaginal foreign body)

#### After ovariectomy (OVH)

- Estrogen influence (remnant ovarian syndrome, exogenous estrogen)
- Absence of estrogen influence (stump endometritis secondary to presence of remnant ovarian syndrome with progesterone influence, uterine stump hemorrhage post-OVH, neoplasia of urogenital tract, trauma, hemorrhagic diathesis, vaginal foreign body)

### Mucopurulent Vaginal Discharge

#### Intact

- Physiologic (onset of diestrus, pregnancy [clear mucus])
- Pathologic (endometritis post estrum or postpartum, abortion, vestibulitis/vaginitis, neoplasia, vaginal foreign body)

#### After ovariectomy

- Vaginitis, stump endometritis secondary to presence of remnant ovarian syndrome with progesterone influence, hypersecretion of vaginal mucosa, neoplasia, vaginal foreign body)

## Weakness

Very nonspecific clinical sign of disease

Metabolic disease

Inflammation

- Infectious disease (bacterial, viral, fungal, rickettsial, protozoal, parasitic)
- Immune-mediated disease

Fever

Electrolyte disorders

- Hypokalemia, hyperkalemia, hyponatremia, hypernatremia, hypocalcemia, hypomagnesemia

Acid–base disorders

Abdominal effusion

Anemia

Poor oxygen delivery

Endocrine disease

- Diabetes mellitus, hypothyroidism, hypoadrenocorticism, hyperadrenocorticism, hypoglycemia, hyperparathyroidism, hypoparathyroidism, pheochromocytoma

Cardiovascular disease

Hypotension, hypertension

Respiratory disease

Skeletal disease

Neuromuscular disease

- Brain disease (encephalitis, cerebrovascular accidents, space-occupying lesions, vestibular disease, idiopathic epilepsy)
- Spinal cord diseases
- Neuropathies (e.g., polyradiculoneuritis, myasthenia gravis, developmental disorders, toxoplasmosis, neosporosis)

Neoplasia

Cachexia

Physical and psychologic stress

Malnutrition

Drugs

- Anticonvulsants, antihistamines, glucocorticoids, tranquilizers, narcotics, cardiac drugs

Toxins

Pain

## Weight Gain

See [Obesity](#).

## Weight Loss

See [Cachexia and Muscle Wasting](#).

---

## PART TWO

# Systemic Approach to Differential Diagnosis

---

Mechanisms of Disease: DAMN-IT VP Scheme  
Section I Cardiopulmonary Disorders  
Section II Dermatologic Disorders  
Section III Endocrinologic and Metabolic Disorders  
Section IV Gastroenterologic Disorders  
Section V Hematologic Disorders  
Section VI Immunologic and Immune-Mediated Disorders  
Section VII Infectious Disease  
Section VIII Joint and Bone Disorders  
Section IX Liver and Exocrine Pancreatic Disorders  
Section X Neoplasia  
Section XI Neurologic and Neuromuscular Disorders  
Section XII Ocular Disorders  
Section XIII Toxicology  
Section XIV Urogenital Disorders  
Section XV Pain Diagnosis  
Section XVI FAST Ultrasound

## Mechanisms of Disease

### DAMNIT-VP Scheme

**D** Degenerative

**A** Anomalous

**M** Metabolic, malformation

**N** Neoplastic, nutritional

**I** Infectious, inflammatory, immune, iatrogenic, idiopathic

**T** Traumatic, toxic

**V** Vascular

**P** Parasitic

---

### SECTION I

# Cardiopulmonary Disorders

---

Arrhythmias  
Arterial Thromboembolism  
Aspiration Pneumonia  
Atrioventricular Valve Disease, Chronic (Mitral or Tricuspid Valve)  
Canine Infectious Tracheobronchitis, Etiologic Agents Associated With  
Cardiomegaly  
Chylothorax  
Congenital Heart Disease  
Heart Failure  
Heartworm Disease  
Hypertension  
Laryngeal and Pharyngeal Disease  
Lower Respiratory Tract Disease  
Mediastinal Disease  
Murmurs  
Myocardial Diseases  
Pericardial Effusion  
Pleural Effusion  
Pulmonary Disease  
Pulmonary Edema  
Pulmonary Thromboembolism  
Tachycardia, Sinus



# Arrhythmias

## Differential Diagnosis

### Slow, Irregular Rhythms

Sinus bradyarrhythmias  
Sinus arrest  
Sick sinus syndrome  
High-grade second-degree atrioventricular (AV) block

### Slow, Regular Rhythms

Sinus bradycardia  
Complete AV block with ventricular escape rhythm  
Atrial standstill with ventricular escape rhythm

### Fast, Irregular Rhythms

Atrial or supraventricular premature contractions  
Paroxysmal atrial or supraventricular tachycardia  
Atrial flutter  
Atrial fibrillation  
Ventricular premature contractions  
Paroxysmal ventricular tachycardia

### Fast, Regular Rhythms

Sinus tachycardia  
Sustained supraventricular tachycardia  
Sustained ventricular tachycardia

### Normal, Irregular Rhythms (require no treatment)

Respiratory sinus arrhythmia  
Wandering pacemaker

# Arterial Thromboembolism

## Clinical Findings

### Acute Limb Paresis

Posterior paresis ("saddle" thrombus: most common presentation)  
Monoparesis (right subclavian artery thrombus; second most common presentation in cats)  
Intermittent claudication  
Severe limb pain  
Cool distal limbs  
Cyanotic nail beds  
Arterial pulse absent  
Contracture of affected muscles  
Vocalization (pain, distress)

### Renal Infarction

Renal pain  
Acute renal failure

### Splenic Infarction

Lethargy  
Anorexia  
Vomiting  
Diarrhea

### Mesenteric Infarction

Abdominal pain  
Vomiting  
Diarrhea

### Cerebral Infarction

Neurologic deficits  
Seizures  
Sudden death

### Signs of Heart Failure

Systolic murmur  
Gallop rhythm  
Tachypnea/dyspnea  
Weakness/lethargy  
Anorexia  
Arrhythmias  
Hypothermia  
Cardiomegaly  
Effusions  
Pulmonary edema

### Hematologic and Biochemical Abnormalities

Azotemia  
Increased alanine aminotransferase (ALT) activity  
Increased aspartate aminotransferase activity  
Increased lactate dehydrogenase activity  
Increased creatine kinase activity  
Hyperglycemia

Lymphopenia  
Disseminated intravascular coagulation

# **Aspiration Pneumonia**

## **Etiology of Aspiration Pneumonia**

### **Esophageal Disorders**

Megaesophagus  
Reflux esophagitis  
Esophageal obstruction  
Myasthenia gravis (localized)  
Bronchoesophageal fistulae

### **Localized Oropharyngeal Disorders**

Cleft palate  
Cricopharyngeal motor dysfunction  
Laryngoplasty  
Brachycephalic airway syndrome

### **Systemic Neuromuscular Disorders**

Myasthenia gravis  
Polyneuropathy  
Polymyopathy

### **Decreased Mentation**

General anesthesia  
Sedation  
Post ictus  
Head trauma  
Severe metabolic disease

### **Iatrogenic**

Force feeding  
Stomach tubes

### **Vomiting (in combination with other predisposing factors)**

# Atrioventricular Valve Disease, Chronic (Mitral or Tricuspid Valve)

## Potential Complications

### Acute Worsening of Pulmonary Edema

Arrhythmias

- Frequent atrial premature contractions
- Paroxysmal atrial/supraventricular contractions
- Atrial fibrillation
- Ventricular tachyarrhythmias
- Rule out drug toxicity (e.g., digoxin)

Ruptured chordae tendineae

Iatrogenic volume overload

- Excessive fluid or blood administration
- High-sodium fluids

High sodium intake

Increased cardiac workload

- Physical exertion
- Anemia
- Infection/sepsis
- Hypertension
- Disease of other organ systems (pulmonary, hepatic, renal, endocrine)
- Environmental stress (heat, humidity, cold, etc.)

Inadequate medication for stage of disease

Erratic or improper drug administration

Myocardial degeneration and poor contractility

### Causes of Reduced Cardiac Output

Arrhythmias

Ruptured chordae tendineae

Cough-related syncope

Left atrial tear, intrapericardial bleeding, cardiac tamponade

Secondary right-sided heart failure

Myocardial degeneration, poor contractility

Increased cardiac workload

## Canine Infectious Tracheobronchitis, Etiologic Agents Associated With

Usually a multietiological disease involving one or more of the following:

- *Bordetella bronchiseptica*
- Canine parainfluenza virus
- Canine adenovirus 2
- Canine influenza virus
- Canine herpes virus
- Canine respiratory coronavirus
- *Mycoplasma* spp.
- *Streptococcus equi* subsp. *Zooepidemicus*
- Canine distemper virus

Most frequent combination is *B. bronchiseptica* with canine parainfluenza virus or canine adenovirus

# Cardiomegaly

## Differential Diagnosis

### Generalized Cardiomegaly

- Dilated cardiomyopathy
- Pericardial effusion
- Mitral and tricuspid valve insufficiency
- Tricuspid dysplasia
- Pericardioperitoneal diaphragmatic hernia
- Ventricular septal defect
- Patent ductus arteriosus

### Left Atrial Enlargement

- Mitral valve insufficiency
- Hypertrophic cardiomyopathy
- Early dilated cardiomyopathy (especially in Doberman Pinschers)
- Subaortic or aortic stenosis

### Left Atrial and Ventricular Enlargement

- Dilated cardiomyopathy
- Hypertrophic cardiomyopathy
- Mitral valve insufficiency
- Aortic valve insufficiency
- Ventricular septal defect
- Patent ductus arteriosus
- Subaortic or aortic stenosis
- Systemic hypertension
- Hyperthyroidism

### Right Atrial and Ventricular Enlargement

- Advanced heartworm disease
- Chronic severe pulmonary disease
- Tricuspid valve insufficiency
- Atrial septal defect
- Pulmonic stenosis
- Tetralogy of Fallot
- Reversed-shunting congenital defects
- Pulmonary hypertension
- Mass lesion within right heart

# Chylothorax

## Diagnostic Criteria

Protein concentration is greater than 2.5 g/dL

Nucleated cell count ranges from 400-10,000/mL

Predominant cell type on cytology is the small lymphocyte (also see neutrophils, macrophages, plasma cells, and mesothelial cells)

Triglyceride concentration of pleural fluid is greater than that of serum (definitive test)

## Diagnostic Tests to Identify Underlying Disease

Cytologic examination of fluid

- Neoplastic cells
- Infectious agents

Thoracic radiography (after fluid removal)

- Cranial mediastinal masses
- Other neoplasia
- Cardiac disease
- Heartworm disease
- Pericardial disease

Ultrasonography (in the presence of fluid)

- Cranial mediastinum
- Mass
- Echocardiography
- Cardiomyopathy
- Heartworm disease
- Pericardial disease
- Congenital heart disease

Ultrasound of fluid pockets near body wall

- Neoplasia
- Lung lobe torsion

Laboratory tests

- Heartworm antibody and antigen tests
- Complete blood count (CBC)
- Serum biochemical profile
- Urinalysis

Lymphangiography

- Preoperative and postoperative assessment of thoracic duct

Computed tomography

## Causes of Chylothorax

### Traumatic

- Blunt force trauma (e.g., vehicular trauma)
- Postthoracotomy

### Nontraumatic

- Neoplasia (especially mediastinal lymphoma in cats)
- Cardiomyopathy
- Dirofilariasis
- Pericardial disease
- Other causes of right heart failure
- Lung lobe torsion
- Diaphragmatic hernia
- Systemic lymphangiectasia



### **Idiopathic (most commonly diagnosed)**

## **Diagnostic Tests to Identify Underlying Cause of Chylothorax in Dogs and Cats**

### **CBC, Serum Chemistry, Urinalysis**

- Evaluation of systemic status

### **Cytologic Examination of Pleural Fluid**

- Infectious agents
- Neoplastic cells

### **Thoracic Radiographs (after fluid removal)**

- Cranial mediastinal masses
- Other neoplasia
- Cardiac disease
- Heartworm disease
- Pericardial disease

### **Ultrasonography (before fluid removal)**

- Cranial mediastinum (masses)
- Echocardiography (cardiomyopathy, heartworm disease, pericardial disease, congenital heart disease)
- Ultrasound of body wall and pleural space (neoplasia, lung lobe torsion)

### **Heartworm Antibody and Antigen Tests**

- Heartworm disease

### **Lymphangiography**

- Preoperative and postoperative assessment of thoracic duct

# Congenital Heart Disease

## Breed Predispositions

### Patent Ductus Arteriosus

Maltese, Pomeranian, Shetland Sheepdog, English Cocker Spaniel, English Springer Spaniel, Keeshond, Bichon Frise, toy and miniature Poodle, Yorkshire Terrier, Collie, Cocker Spaniel, Corgi, German Shepherd, Chihuahua, Kerry Blue Terrier, Labrador Retriever, Newfoundland; female affected more than male

### Subaortic Stenosis

Newfoundland, Golden Retriever, Rottweiler, Boxer, German Shepherd, English Bulldog, Great Dane, German Shorthaired Pointer, Bouvier des Flandres, Samoyed

### Aortic Stenosis

Bull Terrier

### Pulmonic Stenosis

English Bulldog (male affected more than female), Mastiff, Samoyed, Miniature Schnauzer, Newfoundland, West Highland White Terrier, Cocker Spaniel, Beagle, Basset Hound, Airedale Terrier, Boykin Spaniel, Chihuahua, Scottish Terrier, Boxer, Fox Terrier, Chow Chow, Labrador Retriever, Schnauzer, Miniature Pinscher

### Atrial Septal Defect

Samoyed, Doberman Pinscher, Boxer

### Ventricular Septal Defect

English Bulldog, English Springer Spaniel, Keeshond, West Highland White Terrier, cats

### Tricuspid Dysplasia

Labrador Retriever, German Shepherd, Boxer, Weimaraner, Great Dane, Old English Sheepdog, Golden Retriever, various other large breeds

### Mitral Dysplasia

Bull Terrier, German Shepherd, Great Dane, Golden Retriever, Newfoundland, Dalmatian, Mastiff, Rottweiler, cats

### Tetralogy of Fallot

Keeshond, English Bulldog

### Persistent Right Aortic Arch

German Shepherd, Great Dane, Irish Setter

### Cor Triatriatum

Medium- to large-breed dogs (Chow Chow), rarely small-breed dogs or cats

### Peritoneopericardial Diaphragmatic Hernia

Weimaraner



# Heart Failure

## Causes of Chronic Heart Failure

### Left-Sided Heart Failure

#### Volume-Flow Overload

Mitral valve regurgitation (degenerative, congenital, infective)  
Aortic regurgitation (infective endocarditis, congenital)  
Ventricular septal defect  
Patent ductus arteriosus

#### Myocardial Failure

Myocardial ischemia/infarction  
Drug toxicity (e.g., doxorubicin)

#### Pressure Overload

Aortic/subaortic stenosis  
Systemic hypertension

#### Restriction of Ventricular Filling

Hypertrophic cardiomyopathy  
Restrictive cardiomyopathy

### Left- or Right-Sided Heart Failure

#### Myocardial Failure

Idiopathic dilated cardiomyopathy  
Infective myocarditis

#### Volume-Flow Overload

Chronic anemia  
Thyrotoxicosis

### Right-Sided Heart Failure

#### Volume-Flow Overload

Tricuspid endocarditis  
Tricuspid endocardiosis  
Tricuspid dysplasia

#### Pressure Overload

Pulmonic stenosis  
Heartworm disease  
Pulmonary hypertension

#### Restriction to Ventricular Filling

Cardiac tamponade  
Constrictive pericardial disease

#### Sustained Tachyarrhythmias

Supraventricular tachycardia  
Atrial fibrillation

## Chronic Bradyarrhythmias

Complete heart block

## Severity

### Classification Systems

#### New York Heart Association Functional Classification

**Class I:** Heart disease present, but no evidence of heart failure or exercise intolerance; cardiomegaly minimal to absent

**Class II:** Signs of heart disease with evidence of exercise intolerance; radiographic cardiomegaly present

**Class III:** Signs of heart failure with normal activity or signs at night (e.g., cough, orthopnea); radiographic signs of significant cardiomegaly and pulmonary edema or pleural/abdominal effusion

**Class IV:** Severe heart failure with clinical signs at rest or with minimal activity; marked radiographic signs of congestive heart failure (CHF) and cardiomegaly

#### Forrester Classification

**Class I:** Normal cardiac output and pulmonary venous pressure

**Class II:** Pulmonary congestion but normal cardiac output

**Class III:** Low cardiac output and peripheral hypoperfusion with no pulmonary congestion

**Class IV:** Low cardiac output with pulmonary congestion

## Clinical Findings

### Low-Output Signs

Exercise intolerance

Syncope

Weak arterial pulses

Tachycardia

Arrhythmias

Cold extremities

Prerenal azotemia

Cyanosis

### Signs Related to Poor Skeletal Muscle Function

Weight loss

Exercise intolerance

Dyspnea

Decreased muscle mass

### Signs Related to Fluid Retention

#### Left-Sided Heart Failure (Pulmonary Edema)

Dyspnea/orthopnea

Exercise intolerance

Wet lung sounds

Tachypnea

Gallop rhythm

Functional mitral regurgitation

Cyanosis

Cough

#### Right-Sided Heart Failure

Ascites

Subcutaneous edema  
Jugular distension/pulsation  
Hepatomegaly  
Splenomegaly  
Hepatojugular reflux  
Gallop rhythm  
Cardiac arrhythmias

### **Bilateral Signs**

Pleural effusion (dyspnea, muffled heart sounds, cough)

# Heartworm Disease

## Clinical Findings

### Historical Findings

Asymptomatic  
Cough  
Dyspnea  
Weight loss  
Lethargy  
Exercise intolerance  
Poor condition  
Syncope  
Abdominal distension (ascites)

### Physical Findings

Weight loss  
Right-sided murmur (tricuspid insufficiency)  
Split-second heart sound  
Gallop rhythm  
Cough  
Pulmonary crackles  
Dyspnea  
Muffled breath sounds  
Cyanosis  
Right-sided heart failure

- Jugular distension/pulsation
- Hepatosplenomegaly
- Ascites

Pulmonary thromboembolism

- Dyspnea/tachypnea
- Fever
- Hemoptysis

Cardiac arrhythmias/conduction disturbances (rare)  
Caval syndrome

- Hemoglobinuria
- Anemia
- Disseminated intravascular coagulation (DIC)
- Icterus
- Collapse/death

### Clinicopathologic Findings

Eosinophilia  
Nonregenerative anemia  
Neutrophilia  
Basophilia  
Proteinuria  
Hyperbilirubinemia  
Azotemia  
Thrombocytopenia

### Radiographic Signs

Right ventricular enlargement  
Prominent main pulmonary artery segment  
Increased pulmonary artery size

Tortuous pulmonary vessels  
Caudal vena cava enlargement  
Hepatosplenomegaly  
Ascites  
Pleural effusion  
Bronchial/interstitial lung disease

## **Diagnosis in Dogs**

### **Antigen Test Positive and Modified Knott or Filter Test Negative**

- Perform CBC, serum chemistry panel, urinalysis, thoracic radiography
- Start preventative and doxycycline therapy
- Begin adulticide therapy at 60 days

### **Antigen Test Positive and Modified Knott or Filter Test Positive**

- Perform CBC, serum chemistry panel, urinalysis, and thoracic radiography
- Start preventative and doxycycline therapy
- Begin adulticide therapy at 60 days

### **Antigen Test Negative**

- No infection or low heartworm burden
- Start preventative



# Hypertension

## Pulmonary Hypertension

### Potential Clinical Signs

Ascites  
Jugular venous distension/pulsation  
Subcutaneous edema  
Cachexia  
Exercise intolerance, weakness  
Syncope  
Nonspecific respiratory signs

- Coughing
- Tachypnea
- Respiratory distress
- Increased bronchovesicular sounds
- Hemoptysis

Cyanosis

- Right-to-left cardiac shunts
- Severe respiratory disease

Split or loud pulmonic component to second heart sound  
Right or left apical systolic murmurs (tricuspid or mitral regurgitation)

### Radiographic Signs

Cardiomegaly  
Right ventricular enlargement  
Dilated central pulmonary arteries with tapering toward periphery  
Eisenmenger complex (pulmonary undercirculation and right-sided heart enlargement)  
Left atrial enlargement and perihilar to caudodorsal pulmonary infiltrates (left-sided congestive heart failure)

### Echocardiographic Signs

Right ventricular concentric hypertrophy and dilation  
Main pulmonary artery and main branch dilation  
Systolic flattening of interventricular septum  
Paradoxical septal motion  
Reduced left ventricular dimensions in severe pulmonary hypertension caused by ventricular underfilling

### Laboratory Values

Acidosis  
Rule out heartworm disease

## Systemic Hypertension

### Causes of Systemic Hypertension in Dogs and Cats

Renal failure (chronic or acute)  
Hyperadrenocorticism  
Diabetes mellitus  
Pheochromocytoma  
Hyperthyroidism  
Liver disease  
Hyperaldosteronism  
Intracranial lesions (intracranial pressure)  
High-salt diet

Obesity  
Chronic anemia (cats)

## **Clinical Signs of Systemic Hypertension**

### **Ocular Findings**

Hypertensive choroidopathy (edema, vascular tortuosity, hemorrhage, focal ischemia)  
Hypertensive retinopathy (edema, vascular tortuosity, hemorrhage, focal ischemia, atrophy)  
Intraocular hemorrhage (retinal, vitreal, hyphema)  
Papilledema  
Blindness  
Glaucoma  
Secondary corneal ulcers

### **Neurologic Findings**

Edema (intracranial pressure)  
Hypertensive encephalopathy (lethargy, behavioral changes)  
Cerebrovascular accident (focal ischemia, hemorrhage)  
Seizures/collapse  
Vestibular signs

### **Renal**

Polyuria/polydipsia  
Glomerulosclerosis/proliferative glomerulitis  
Renal tubular degenerative and fibrosis  
Further deterioration in renal function

### **Cardiac**

Left ventricular hypertrophy  
Murmur or gallop sound  
Aortic dilation  
Aneurysm or dissection rare

### **Other**

Epistaxis

# Laryngeal and Pharyngeal Disease

## Differential Diagnosis

Laryngeal paralysis  
Brachycephalic airway syndrome  
Acute laryngitis  
Laryngeal neoplasia  
Nasopharyngeal polyp  
Abscess  
Tonsillitis  
Pharyngitis  
Obstructive laryngitis  
Laryngeal collapse  
Trauma  
Foreign body  
Extraluminal mass  
Elongated soft palate  
Cleft palate  
Soft palate hypoplasia  
Pharyngeal neoplasia  
Granuloma  
Pharyngeal mucocoeles  
Web formation  
Nasopharyngeal stenosis

## Causes of Laryngeal Paralysis

### Idiopathic

### Polyneuropathy and Polymyopathy

Idiopathic  
Immune mediated  
Endocrinopathy

- Hypothyroidism
- Hypoadrenocorticism

Toxicity  
Congenital disease

### Ventral Cervical Lesion

Nerve trauma

- Direct trauma
- Inflammation
- Fibrosis

Neoplasia  
Other inflammatory or mass lesion

### Anterior Thoracic Lesion

Neoplasia  
Trauma

- Postoperative
- Other

Other inflammatory or mass lesion

### Myasthenia Gravis



# Lower Respiratory Tract Disease

## Differential Diagnosis

### Disorders of Trachea and Bronchi

Canine infectious tracheobronchitis  
Collapsing trachea  
Bacterial infection  
Mycoplasmal infection  
Bronchial asthma  
Neoplasia  
Allergic bronchitis  
Feline bronchitis  
Bronchial compression

- Left atrial enlargement
- Hilar lymphadenopathy

Acute bronchitis  
Canine chronic bronchitis/bronchiectasis  
Parasites (*Oslerus osleri*, *Filaroides osleri*)  
Tracheal tear  
Primary ciliary dyskinesia  
Airway foreign body  
Chronic aspiration

### Disorders of Pulmonary Parenchyma

Infectious disease

- Viral pneumonia (canine influenza, canine distemper virus, canine adenovirus, canine parainfluenza, feline calicivirus, feline infectious peritonitis [FIP], pneumonia secondary to feline leukemia virus [FeLV] or feline immunodeficiency virus [FIV])
- Bacterial pneumonia
- Protozoal pneumonia (toxoplasmosis)
- Fungal pneumonia (blastomycosis, histoplasmosis, coccidioidomycosis)
- Rickettsial disease (*Rickettsia rickettsii*, *Ehrlichia* spp.)
- Parasitism
- Heartworm disease
- Pulmonary parasites (*Paragonimus*, *Aelurostrongylus*, *Capillaria*, *Crenosoma* spp.)
- Larval migration of *Toxocara canis*

Aspiration pneumonia  
Pulmonary infiltrates with eosinophils  
Eosinophilic pulmonary granulomatosis  
Pulmonary neoplasia (primary, metastatic, lymphosarcoma, lymphomatoid granulomatosis, malignant histiocytosis)  
Pulmonary hypertension  
Pulmonary contusions  
Pulmonary thromboembolism  
Pulmonary edema  
Acute respiratory distress syndrome (ARDS)  
Lung lobe torsion  
Pulmonary fibrosis  
Pickwickian syndrome (obesity)  
Idiopathic interstitial pneumonias



## Mediastinal Disease

### Differential Diagnosis of Lesions Associated with Focal Mediastinal Enlargement

Pneumomediastinum  
Mediastinitis (*Histoplasma*, *Cryptococcus*, *Actinomyces*, *Nocardia*, *Spirocerca* spp.)  
Mediastinal hemorrhage  
Mediastinal cysts  
Nonneoplastic mediastinal masses (fungal pyogranulomas, abscesses, granulomas, lymphadenopathy, hematomas)  
Mediastinal neoplasia (lymphosarcoma)  
Thymoma  
Obesity  
Thymic hemorrhage  
Heart base mass  
Neurogenic tumor  
Tracheal mass  
Esophageal mass, foreign body, or dilatation  
Ectopic thyroid tissue  
Mediastinal edema  
Vascular mass (aorta, cranial vena cava)  
Paraspinal or spinal mass  
Aortic stenosis  
Patent ductus arteriosus  
Left atrial enlargement  
Main pulmonary artery mass (poststenotic dilatation)  
Hiatal hernia  
Diaphragmatic hernia or mass  
Aortic aneurysm  
Gastroesophageal intussusception  
Peritoneopericardial diaphragmatic hernia

# Murmurs

## Clinical Findings

### Systolic Murmurs

Functional murmurs (point of maximal impulse [PMI] over left-sided heart base, decrescendo or crescendo-decrescendo)

- Innocent puppy murmurs
- Physiologic murmurs (anemia, fever, high sympathetic tone, hyperthyroidism, peripheral arteriovenous fistula, marked bradycardia, hypoproteinemia, athletic heart)

Mitral valve insufficiency (left apex, typically holosystolic)

Ejection murmurs (typically left-sided heart base)

- Subaortic stenosis (low left base and right base)
- Pulmonic stenosis (high left base)
- Dynamic muscular obstruction

Right-sided murmurs (usually holosystolic)

- Tricuspid insufficiency (right apex, may see jugular pulse)
- Ventricular septal defect (PMI over right sternal border)

### Diastolic Murmurs

Aortic insufficiency from bacterial endocarditis (left-sided heart base)

Aortic valve congenital malformations (left base)

Aortic valve degenerative disease (left base)

Pulmonic insufficiency (left base)

### Continuous Murmurs

Patent ductus arteriosus (PMI high left base above pulmonic area)

### Concurrent Systolic and Diastolic Murmurs (To-and-Fro Murmurs)

Subaortic stenosis with aortic insufficiency

Pulmonic stenosis with pulmonic insufficiency

## Grading

**Grade I:** Very soft murmur; heard only in quiet surroundings after minutes of listening

**Grade II:** Soft murmur but easily heard

**Grade III:** Moderate-intensity murmur

**Grade IV:** Loud murmur; no precordial thrill

**Grade V:** Loud murmur with palpable precordial thrill

**Grade VI:** Very loud murmur; can be heard with stethoscope off chest wall; palpable precordial thrill



# Myocardial Diseases

## Differential Diagnosis, Dogs

### Dilated Cardiomyopathy

#### Primary (idiopathic, most common)

Genetic (Doberman Pinscher, Boxer, Cocker Spaniel, Great Dane, Portuguese Water Dog, Newfoundland, Dalmatian, Irish Wolfhound, Old English Sheepdog, Scottish Deerhound; Abyssinian, Burmese, and Siamese cats overrepresented)

#### Secondary

##### Nutritional Deficiencies

L-Carnitine (Boxer, Doberman Pinscher, Great Dane, Irish Wolfhound, Newfoundland, Cocker Spaniel)  
Taurine

##### Myocardial Infection

Viral myocarditis (acute viral infections, e.g., parvovirus, West Nile virus)  
Bacterial myocarditis (secondary to bacteremia from infections elsewhere in body)  
Bartonellosis  
Lyme disease: *Borrelia burgdorferi*  
Protozoal myocarditis (*Trypanosoma cruzi* [Chagas disease], *Toxoplasma gondii*, *Neospora caninum*, *Babesia canis*, *Hepatozoon canis*)  
Fungal myocarditis (rare, *Aspergillus*, *Cryptococcus*, *Coccidioides*, *Histoplasma*, *Paecilomyces* spp.)  
Rickettsial myocarditis (rare, *Rickettsia rickettsii*, *Ehrlichia canis*, *Bartonella* spp.),  
Algae-like organisms (rare, *Prototheca* spp.)  
Nematode larval migration (*Toxocara* spp.)

##### Trauma

##### Ischemia

##### Infiltrative Neoplasia

##### Hyperthermia

##### Irradiation

##### Electric Shock

##### Cardiotoxins

Doxorubicin; ethyl alcohol; plant toxins such as foxglove, black locust, buttercup, lily of the valley, and gossypol; cocaine; anesthetic drugs; catecholamines; monensin  
Transmissible myocarditis-diaphragmitis of cats

### Hypertrophic Cardiomyopathy (uncommon in dogs)

### Arrhythmogenic Right Ventricular Cardiomyopathy (rare)

#### Noninfective Myocarditis

Catecholamines; heavy metals; antineoplastic drugs (doxorubicin, cyclophosphamide, 5-fluorouracil, interleukin-2, interferon- $\alpha$ ); stimulant drugs (thyroid hormone, cocaine, amphetamines, lithium)  
Immune-mediated diseases, pheochromocytoma

Wasp and scorpion stings, snake venom, spider bite

## Differential Diagnosis, Cats

### Hypertrophic Cardiomyopathy

#### Primary (Idiopathic)

Maine Coon, Persian, Ragdoll, and American Shorthair may be predisposed.

#### Secondary

Hyperthyroidism

Hypersomatotropism (acromegaly)

Infiltrative myocardial disease (lymphoma)

### Restrictive Cardiomyopathy

### Dilated Cardiomyopathy

Taurine-deficient diets

Doxorubicin

End stage of other myocardial metabolic, toxic, or infectious process

### Arrhythmogenic Right Ventricular Cardiomyopathy

### Myocarditis

Viral (coronavirus, other viruses)

Bacterial (bacteremia, *Bartonella* spp.)

Protozoal (*Toxoplasma gondii*)

# Pericardial Effusion

## Differential Diagnosis

### Bacterial Pericarditis

Secondary to foxtail (*Hordeum* spp.) migration  
Secondary to penetrating animal bite  
Disseminated tuberculosis

### Fungal Pericarditis

Coccidioidomycosis  
Aspergillosis  
Actinomycosis

### Viral Pericarditis

FIP  
Canine distemper virus

### Protozoal Pericarditis

Toxoplasmosis  
Other systemic protozoal infections

### Left Atrial Rupture (Secondary to Mitral Valve Disease)

### Neoplasia

Hemangiosarcoma  
Mesothelioma  
Heart base tumor (aortic body tumor, chemodectoma, ectopic thyroid tumor, ectopic parathyroid tumor, connective tissue neoplasms)  
Fibrosarcoma  
Lymphosarcoma  
Rhabdomyosarcoma

### Other

Penetrating trauma  
Pericardioperitoneal diaphragmatic hernia  
Hypoalbuminemia  
Pericardial cyst  
Coagulation disorders  
Congestive heart failure  
Uremia  
Idiopathic

## Pleural Effusion

### Differential Diagnosis

#### Transudates and Modified Transudates

Right-sided heart failure  
Pericardial disease  
Hypoalbuminemia  
Neoplasia  
Diaphragmatic hernia

#### Nonseptic Exudates

FIP  
Neoplasia  
Diaphragmatic hernia  
Lung lobe torsion

#### Septic Exudates

Pyothorax

#### Chylous Effusion

Chylothorax

#### Hemorrhage

Trauma  
Bleeding disorder  
Neoplasia  
Lung lobe torsion

### Diagnostic Approach in Dogs and Cats with Pleural Effusion Based on Fluid Type

#### Pure and Modified Transudates

Right-sided heart failure, pericardial effusion (evaluate pulses, auscultation, electrocardiogram [ECG], thoracic radiography, echocardiography)  
Hypoalbuminemia (serum albumin concentration)  
Neoplasia, diaphragmatic hernia (thoracic radiography, thoracic ultrasound, computed tomography [CT], thoracoscopy, thoracotomy)

#### Nonseptic Exudates

FIP (pleural fluid cytology [most reliable test], CBC, serum chemistry, ophthalmoscopic examination, serum or fluid electrophoresis, coronavirus antibody titer, polymerase chain reaction [PCR] of tissues or effusion)  
Neoplasia, diaphragmatic hernia (thoracic radiography, thoracic ultrasound, CT, thoracoscopy, thoracotomy)  
Lung lobe torsion (thoracic radiography, ultrasound, bronchoscopy, thoracotomy)

#### Septic Exudates

Pyothorax (Gram stain, aerobic and anaerobic culture, cytology)

#### Chylous Effusion

Chylothorax (protein concentration, nucleated cell count, cytology, triglyceride)

#### Hemorrhagic

Trauma (history)

Bleeding disorder (systemic examination, coagulation tests platelet count)

Neoplasia (thoracic radiography, thoracic ultrasound, CT, thoracoscopy, thoracotomy)

Lung lobe torsion (thoracic radiography, ultrasound, bronchoscopy, thoracotomy)

# Pulmonary Disease

## Differential Diagnosis Based on Radiographic Patterns

### Alveolar Pattern

Pulmonary edema (cardiogenic or noncardiogenic)  
Infectious pneumonia (bacterial, parasitic, protozoal, viral)  
Aspiration pneumonia  
Atelectasis  
Drowning  
Smoke inhalation  
ARDS (acute respiratory distress syndrome)  
Hemorrhage

- Neoplasia (primary and metastatic)
- Fungal pneumonia (severe)
- Pulmonary contusion
- Thromboembolic disease
- Systemic coagulopathy

### Bronchial Pattern

Feline bronchitis/asthma  
Allergic bronchitis  
Bacterial bronchitis  
Canine chronic bronchitis  
Bronchiectasis  
Pulmonary parasites  
Bronchial calcification

### Vascular Pattern

#### Enlarged Arteries

Heartworm disease  
Thromboembolic disease  
Pulmonary hypertension

#### Enlarged Veins

Left-sided heart failure

#### Enlarged Arteries and Veins (Pulmonary Overcirculation)

#### Left-to-Right Shunts

Patent ductus arteriosus  
Ventricular septal defect  
Atrial septal defect

#### Small Arteries and Veins

##### Pulmonary Undercirculation

Cardiovascular shock  
Hypovolemia

- Severe dehydration
- Blood loss
- Hypoadrenocorticism

Pulmonic valve stenosis

## **Hyperinflation of Lungs**

Feline bronchitis

Allergic bronchitis

## **Nodular Interstitial Pattern**

Mycotic infection

- Blastomycosis
- Histoplasmosis
- Coccidioidomycosis

Neoplasia

Pulmonary parasites

- *Aelurostrongylus* infection
- *Paragonimus* infection

Pulmonary abscess

- Bacterial pneumonia
- Foreign body

Pulmonary infiltrates with eosinophils

Miscellaneous inflammatory diseases

Inactive lesions

## **Reticular Interstitial Patterns**

Infection

- Viral pneumonia
- Bacterial pneumonia
- Toxoplasmosis
- Mycotic pneumonia

Parasitic infestation

Neoplasia

Pulmonary fibrosis

Pulmonary infiltrates with eosinophils

Miscellaneous inflammatory diseases

Hemorrhage (mild)

Old dog lung

# Pulmonary Edema

## Causes

### Vascular Overload

Cardiogenic

- Left-sided heart murmur
- Left-to-right shunt

Overhydration

### Decreased Plasma Oncotic Pressure

Hypoalbuminemia

- Gastrointestinal (GI) loss
- Renal loss (glomerular disease)
- Liver disease (lack of production)
- Iatrogenic overhydration

### Increased Vascular Permeability

Sepsis

Shock

Drugs or toxins

Snake envenomation

Cisplatin (cats)

Trauma

- Pulmonary
- Multisystemic

Inhaled toxins

- Smoke inhalation
- Gastric acid aspiration
- Oxygen toxicity

Electrocution

Pancreatitis

Uremia

Virulent babesiosis

DIC

Inflammation/vasculitis

### Other Causes

Thromboembolism

Postobstruction (strangulation, laryngeal paralysis, pulmonary reexpansion)

Near-drowning

Neurogenic edema

- Seizures
- Head trauma

Lung lobe torsion

Bacterial pneumonia

Pulmonary contusion

Hyperoxia

High altitude

Air embolus

Pheochromocytoma

### Lymphatic Obstruction (rare)

Neoplasia





# Pulmonary Thromboembolism

## Causes

### **Embolization of Thrombi (any condition that predisposes to venous stasis, endothelial injury, and hypercoagulability)**

Heartworm disease  
Immune-mediated hemolytic anemia  
Systemic inflammatory disease  
Neoplasia  
Cardiac disease  
Cardiomyopathy  
Endocarditis  
Congestive heart failure  
Protein-losing nephropathy  
Protein-losing enteropathy  
Hyperadrenocorticism  
Pancreatitis  
Disseminated intravascular coagulation  
Anatomic abnormality (e.g., aneurysm, AV fistula)  
Hyperviscosity (polycythemia, leukemia, hyperglobulinemia)  
Hypoviscosity (anemia)  
Sepsis  
Shock  
Intravenous catheterization  
Injection of irritating substance  
Prolonged recumbency  
Reperfusion injury  
Atherosclerosis/arteriosclerosis  
Trauma  
Recent surgery  
Hyperhomocysteinemia  
Vasculitis

### **Embolization of Parasites**

Heartworm disease

### **Embolization of Fat**

### **Embolization of Neoplastic Cells**

# Tachycardia, Sinus

## Causes

Anxiety/fear  
Excitement  
Exercise  
Pain  
Hyperthyroidism  
Hyperthermia/fever  
Anemia  
Congestive heart failure  
Hypoxia  
Shock  
Hypotension  
Sepsis  
Drugs (anticholinergics, sympathomimetics)  
Toxicity (e.g., chocolate, hexachlorophene)  
Electric shock

---

## SECTION II

# Dermatologic Disorders

---

Allergic Skin Disease  
Alopecia, Endocrine  
Claw Disorders  
Erosions and Ulcerations of Skin or Mucous Membranes  
Folliculitis  
Otitis Externa, Chronic  
Parasitic Dermatoses  
Pigmentation  
Pyoderma

# Allergic Skin Disease

## Clinical Findings

### Flea Allergy

#### Dogs

Papular rash  
Caudal distribution of lesions most common

#### Cats

Miliary dermatitis, especially over caudal back, around neck and chin  
Eosinophilic granuloma complex

### Atopy and Cutaneous Signs of Food Hypersensitivity

Signs of these two types of allergies are similar.  
Atopy tends to occur primarily in young adults, whereas food hypersensitivity can begin at any age. Atopy is usually seasonal at first but may become less seasonal.

#### Dogs

Papular rash  
Pruritus and self-trauma  
Lesions of face, ears, feet, and perineum  
Recurrent otitis externa  
Excoriation  
Lichenification  
Pigmentary changes  
Secondary pyoderma

#### Cats

Miliary dermatitis  
Eosinophilic dermatitis

### Allergic Contact Dermatitis

Rarest of allergic dermatoses  
Lesions tend to be confined to hairless or sparsely haired skin (ventral abdomen, neck, and chest; ventral paws but not pads; perineum; lateral aspect of pinnae).  
Acutely: erythema, macules, papules, vesicles  
Chronically: alopecic plaques, hyperpigmentation, hypopigmentation, excoriation, lichenification

# Alopecia, Endocrine

## Causes

Hypothyroidism

Hyperadrenocorticism

Diabetes mellitus

Adrenal sex hormone deficiency (alopecia X)

Growth hormone deficiency (pituitary dwarfism)

Growth hormone–responsive dermatosis in adult dogs

Castration-responsive dermatosis

Hyperestrogenism

- Sertoli cell tumor (male dog)
- Intact female dog

Hypoestrogenism (poorly understood)

- Estrogen-responsive dermatosis of spayed female dogs
- Feline endocrine alopecia

Hypoandrogenism

- Testosterone-responsive dermatosis (male dog)
- Feline endocrine alopecia

Telogen defluxion (effluvium): often after recent pregnancy or diestrus

Progestin excess (excess of progesterone or 17-hydroxyprogesterone)

## Clinical Findings

### Nonspecific Features of Endocrine Disease

Bilaterally symmetric alopecia

Follicular dilation, follicular keratosis, follicular atrophy

Orthokeratotic hyperkeratosis

Predominance of telogen hair follicles

Sebaceous gland atrophy

Epidermal atrophy

Thin dermis

Epidermal melanosis

Dermal collagen atrophy

### Features Suggestive of Specific Endocrine Disorder

Hypothyroidism

- Vacuolated and/or hypertrophied arrector pili muscles, increased dermal mucin content, thick dermis

Hyperadrenocorticism

- Calcinosis cutis, comedones, absence of erector pili muscles

Hyposomatotropism

- Decreased amount and size of dermal elastin fibers

Growth hormone– and castration-responsive dermatoses

- Excessive trichilemmal keratinization (flame follicles)

## Claw Disorders

### Differential Diagnosis for Abnormal Claws

#### **Bacterial Claw Infection—almost always secondary to an underlying cause**

- Trauma—usually one claw affected
- Hypothyroidism
- Hyperadrenocorticism
- Allergies
- Autoimmune disorders
- Symmetrical lupoid onychodystrophy
- Neoplasia

#### **Fungal Claw Infection**

- Typically caused by dermatophytes

#### **Symmetrical Lupoid Onychodystrophy**

- Suspected to be immune mediated. German Shepherds and Rottweilers may be predisposed. Acute onset of claw loss, initially 1-2 but eventually all claws slough. Replacement claws are misshapen, soft or brittle, discolored, and friable and usually slough again. Feet are painful and pruritic. Paronychia is uncommon unless secondary bacterial infection is present.

#### **Drug Eruption**

#### **Vasculitis**

### Diagnostic Tests for Abnormal Claws

- Cytology—suppurative to pyogranulomatous inflammation with bacteria
- Bacterial culture of exudates from claw or claw fold. Mixed infections common. *Staphylococcus* spp. usually isolated
- Fungal culture—*Trichophyton* spp. most commonly isolated, but may also see *Microsporum* spp. or *Malassezia* spp.
- Radiography—rule out osteomyelitis
- Dermatohistopathology—(P3 amputation) only recommended to rule out neoplasia. With symmetric lupoid onychodystrophy, see basal cell hydropic degeneration, degeneration or apoptosis of individual keratinocytes in the basal layer, pigmentary incontinence, and lichenoid interface dermatitis. Systemic lupoid onychodystrophy is most commonly diagnosed by typical history and clinical signs along with ruling out other differentials.

# Erosions and Ulcerations of Skin or Mucous Membranes

## Differential Diagnosis, Dogs

### Excoriation from Any Pruritic Skin Disease

#### Infection

##### Bacterial Pyoderma

Surface (pyotraumatic moist dermatitis, intertrigo)  
Deep (folliculitis, furunculosis, bacterial stomatitis)

##### Fungal

Yeast infection (*Malassezia pachydermatis*, *Candida* spp.)  
Dermatophytosis  
Systemic fungal infection (blastomycosis, coccidioidomycosis, cryptococcosis, histoplasmosis, others)  
Subcutaneous mycoses (pythiosis, zygomycosis, phaeohyphomycosis, sporotrichosis, eumycotic mycetoma, others)

##### Parasitic

Demodicosis

#### Neoplasia

Squamous cell carcinoma  
Epitheliotropic lymphoma

#### Metabolic Derangements

Uremia/renal failure  
Necrolytic migratory erythema  
Calcinosis cutis (hyperadrenocorticism)

#### Physical/Chemical Injury

Drug reactions  
Urine scald  
Thermal injury (burn, freeze)  
Solar injury

#### Immune-Mediated Disorders

Discoid lupus erythematosus (DLE)  
Pemphigus  
Uveodermatologic syndrome  
Miscellaneous autoimmune subepidermal vesiculobullous diseases (bullous pemphigoid, epidermolysis acquisita, linear IgA bullous disease, mucocutaneous pemphigoid, bullous systemic lupus-type 1)

#### Miscellaneous

Arthropod bites  
Dermatomyositis  
Dystrophic epidermolysis bullosa, junctional epidermolysis bullosa  
Idiopathic ulceration of Collies  
Toxic epidermal necrolysis, erythema multiforme (EM)

## Differential Diagnosis, Cats



## **Infection**

### **Viral**

Calicivirus  
Herpesvirus

### **Bacterial**

Atypical mycobacteriosis

### **Fungal**

Cryptococcosis  
Systemic and subcutaneous mycoses  
Sporotrichosis

## **Neoplasia**

Squamous cell carcinomas (especially white, outdoor cats)  
Fibrosarcoma  
Cutaneous lymphoma

## **Metabolic Derangements**

Uremia/renal disease

## **Physical/Chemical Injury**

Thermal  
Drug reactions

## **Immune-Mediated Disorders**

Bullous pemphigoid  
Pemphigus foliaceus  
Plasma cell pododermatitis  
Toxic epidermal necrolysis

## **Inflammatory/Allergic Disorders**

Eosinophilic plaque  
Indolent ulcer  
Arthropod bites

## **Miscellaneous/Idiopathic**

Dystrophic epidermolysis bullosa  
Idiopathic ulceration of dorsal neck  
Junctional epidermolysis bullosa

## Folliculitis

### Differential Diagnosis

#### Superficial Folliculitis

Inflammation of hair follicles

- Bacterial pyoderma
- Fungal (dermatophytosis)
- Parasitic (demodicosis, *Pelodera* dermatitis)

#### Deep Folliculitis/Furunculosis

Inflammation of hair follicles with subsequent follicular rupture into dermis and subcutaneous tissues

- Deep pyodermas

# Otitis Externa, Chronic

## Primary Causes

### Allergy

Atopy  
Adverse reactions to foods  
Contact dermatitis

### Parasites

*Otodectes cynotis*  
*Notoedres cati*  
*Sarcoptes scabiei*  
*Demodex* spp.  
Chiggers  
Flies  
Ticks (spinous ear tick)

### Dermatophytes

### Endocrine Disorders

### Hypothyroidism

### Foreign Bodies

Foxtails, hair, etc.

### Glandular Conditions

Ceruminous gland hyperplasia  
Sebaceous gland hyperplasia or hypoplasia  
Altered type or rate of secretions

### Autoimmune Diseases

Systemic lupus erythematosus (SLE)  
Pemphigus foliaceus/erythematosus  
Cold agglutinin disease  
Juvenile cellulitis

### Viruses

Distemper

### Miscellaneous

Solar dermatitis  
Frostbite  
Vasculitis/vasculopathy  
Eosinophilic dermatitis  
Sterile eosinophilic folliculitis  
Relapsing polychondritis

## Predisposing Factors

### Conformation

Stenotic canals  
Hair in canals

Pendulous pinnae  
Hairy, concave pinna

### **Excessive Moisture**

Swimmer's ear  
High-humidity climate

### **Excessive Cerumen Production**

Secondary to underlying disease  
Primary (idiopathic)

### **Treatment Effects**

Trauma from cotton swabs  
Topical irritants  
Superinfections from altering microflora

### **Obstructive Ear Disease**

Polyps  
Granulomas  
Tumors

### **Systemic Disease**

Immunosuppression  
Debilitation  
Negative catabolic states

## **Perpetuating Factors**

**Bacteria (most commonly *Staphylococcus* spp., *Streptococcus* spp., *Pseudomonas* spp., *Proteus*, *Escherichia coli*)**

**Yeast (*Malassezia pachydermatis*)**

### **Progressive Pathologic Changes**

Hyperkeratosis  
Hyperplasia  
Epithelial folds  
Apocrine gland hypertrophy  
Hidradenitis  
Fibrosis

### **Otitis Media**

Purulent  
Caseated or keratinous  
Cholesteatoma  
Proliferative  
Destructive osteomyelitis

# Parasitic Dermatoses

## Classification

### Fleas (*Ctenocephalides felis* most common)

Flea infestation

Flea allergy dermatitis

- Caudal distribution of lesions (dogs)
- Miliary dermatitis (cats)

### Demodicosis

Dog (*Demodex canis*, *Demodex injai*, *Demodex cornei*)

Cat (*Demodex cati*, *Demodex gatoi*)

### Sarcoptic Mange

*Sarcoptes scabiei* (dogs, rarely cats)

*Notoedres cati* (cats, rarely dogs)

### Ear Mites

*Otodectes cynotis* (common in both dogs and cats)

### Cheyletiellosis

*Cheyletiella yasguri* (primary host is dogs)

*C. blakei* (primary host is cats)

*C. parasitovorax* (primary host is rabbits)

All *Cheyletiella* species freely contagious from one species to another

### Chiggers

Larval stage (six-legged, bright red or orange) is the parasitic stage; nymph and adult are free living.

### Ticks

Brown dog tick (*Rhipicephalus sanguineus*)

American dog tick (*Dermacentor variabilis*)

Rocky Mountain wood tick (*Dermacentor andersoni*)

Lone star tick (*Amblyomma americanum*)

Deer tick (*Ixodes dammini*): primary vector of *Borrelia burgdorferi*

Spinous ear tick (*Otobius megnini*)

### Lice

Sucking lice of dogs (*Linognathus setosus*)

Biting lice of dogs (*Trichodectes canis*, *Heterodoxus springer*)

Lice of cats (*Felicola subrostrata*)

### Insects of Order Diptera

Mosquitoes: eosinophilic dermatitis (especially cats)

Black flies, stable flies, horn flies, houseflies: attack ear pinnae of dogs

Myiasis (development of fly larvae in skin or hair coat): screwworm, blow flies, flesh flies

*Cuterebra* fly larva

### Helminth Parasites

Hookworm dermatitis (*Ancylostoma*, *Uncinaria*)

Pelodera dermatitis (*Pelodera strongyloides*)

Dracunculiasis (*Dracunculus insignis*)



## Pigmentation

### Differential Diagnosis for Changes in Skin Pigmentation

#### Hypopigmentation

Vitiligo (Tervuren, Rottweiler, Doberman Pinscher, Newfoundland, Collie, German Shorthaired Pointer, Old English Sheepdog, Siamese cat)  
Uveodermatologic syndrome (northern breeds such as Siberian Husky, Samoyed, Akita)  
Acquired idiopathic hypopigmentation of nose (Labrador Retriever, Golden Retriever, Malamute, Siberian Husky, Samoyed, Poodle, German Shepherd)  
DLE (German Shepherd, Collie, others)  
Dermatomyositis (Collie, Shetland Sheepdog, Beauceron Shepherd)

#### Hyperpigmentation

##### Postinflammatory Hyperpigmentation

##### Any Chronic Pruritic Skin Disease

Atopy  
Adverse food reactions  
Pyoderma  
*Malassezia* dermatitis  
Sarcoptic mange  
EM  
Many others

##### Demodicosis

##### Endocrinopathies

Hypothyroidism  
Hyperadrenocorticism

##### Dermatophytosis

##### Nevus

##### Lentigo

##### Lentigo simplex in orange cats

##### Acanthosis nigricans (Dachshunds)

##### Feline acromelanism

##### Urticaria pigmentosa (Sphinx cats)

##### Neoplasia (melanoma)

# Pyoderma

## Differential Diagnosis

### Surface Pyoderma

Pyotraumatic dermatitis (acute moist dermatitis, “hot spot”)

Intertrigo (skin fold dermatitis)

### Superficial Pyoderma

Impetigo (subcorneal pustules of sparsely haired skin)

- Puppy pyoderma

Bullous impetigo

- Hyperadrenocorticism, hypothyroidism, diabetes mellitus

Mucocutaneous pyoderma

- Dogs (German Shepherds predisposed)

Superficial bacterial folliculitis

- *Staphylococcus pseudintermedius* most common
- Local trauma secondary to pruritus (allergy, fleas, scabies, demodicosis, etc.)

Dermatophilosis (rare, actinomycotic superficial crusting dermatitis)

Methicillin-resistant *Staphylococcus pseudintermedius*

### Deep Pyoderma

Always secondary to predisposing problem

Localized lesion (laceration, penetrating wound, animal bite, foreign body)

Generalized (suspect underlying systemic disease)

Clinical syndromes associated with deep pyoderma

- Deep folliculitis, furunculosis, cellulitis
- Pyotraumatic folliculitis, furunculosis
- Nasal folliculitis, furunculosis
- Muzzle folliculitis and furunculosis
- Pododermatitis (interdigital pyoderma)
- German Shepherd Dog folliculitis, furunculosis, cellulitis
- Acral lick furunculosis
- Aerobic cellulitis
- Anaerobic cellulites
- Subcutaneous abscesses
- Bacterial pseudomycetoma
- Mycobacterial granulomas
  - Cutaneous tuberculosis (*Mycobacterium tuberculosis*, *M. bovis*)
  - Feline leprosy (*M. lepraemurium*)
  - Opportunistic mycobacterial granulomas
- Actinomycosis
- Actinobacillosis
- Nocardiosis

### Miscellaneous Bacterial Infections

Brucellosis, plague, borreliosis, *Trichomycosis axillaris*, 1-form infections

---

## SECTION III





# Endocrinologic and Metabolic Disorders

---

Acromegaly  
Adrenal Tumors  
Cretinism (Hypothyroidism in Puppies)  
Diabetes Insipidus  
Diabetic Ketoacidosis  
Diabetes Mellitus  
Gastrinoma (Zollinger–Ellison Syndrome)  
Glucagonoma  
Hyperadrenocorticism  
Hyperglycemia  
Hypoadrenocorticism  
Hypoglycemia  
Hyponatremia/hyperkalemia  
Insulinoma  
Parathyroidism  
Pheochromocytoma  
Pituitary Dwarfism  
Thyroid Disease

## Acromegaly

In dogs, acromegaly is caused by endogenous progesterone from the luteal phase of the estrous cycle or by exogenous progesterone used for estrous prevention. Elevated progesterone, in turn, stimulates excessive growth hormone secretion of mammary origin. In cats, acromegaly is caused by a pituitary adenoma, usually a macroadenoma, which secretes excessive amounts of growth hormone. Physical changes are less pronounced in cats than in dogs.

### Clinical Findings, Dogs

Hypertrophy of mouth, tongue, and pharynx  
Thick skin folds, myxedema, hypertrichosis  
Prognathism  
Wide interdental spacing  
Visceral organomegaly  
Insulin-resistant diabetes mellitus  
Polyuria  
Polyphagia  
Elevated alkaline phosphatase (ALP)

### Clinical Findings, Cats

Physical changes most pronounced on head, but all the physical changes listed for dogs may be seen.

Insulin-resistant diabetes mellitus (severe)  
Degenerative arthropathy/lameness  
Polyuria/polydipsia  
Polyphagia  
Panting  
Lethargy/exercise intolerance  
Dyspnea secondary to hypertrophic cardiomyopathy and heart failure  
Neurologic signs when macroadenoma becomes large

- Lethargy, stupor
- Adipsia
- Anorexia
- Temperature deregulation
- Circling
- Seizures
- Pituitary dysfunction
  - Hypogonadism
  - Hypothyroidism
  - Hypoadrenocorticism (feline acromegaly may also coexist with pituitary-dependent hyperadrenocorticism)

## Adrenal Tumors

### Differential Diagnosis

#### Nonfunctional Adrenal Tumor (dog, rarely cat)

No hormone secreted  
Diagnosis by exclusion  
Histopathology

#### Functional Adrenocortical Tumor

##### Cortisol-Secreting Tumor

Hyperadrenocorticism (Cushing syndrome) (dog, rarely cat)  
Diagnosis by adrenocorticotrophic hormone (ACTH) stimulation test, low-dose dexamethasone suppression test, adrenal ultrasound, CT scan

##### Aldosterone-Secreting Tumor

Hyperaldosteronism (Conn syndrome) (cat, rarely dog)  
Diagnosis by assessing Na/K, ACTH stimulation test (measure aldosterone)

##### Progesterone-Secreting Tumor

Mimics hyperadrenocorticism (cat, less commonly dog)  
Diagnosis by measuring serum progesterone

##### Steroid Hormone Precursor–Secreting Tumor

17-hydroxyprogesterone  
Mimics hyperadrenocorticism (dog)  
Diagnosis by ACTH stimulation test (measure steroid hormone precursors)  
Deoxycorticosterone  
Mimics hyperadrenocorticism (dog)  
Diagnosis by ACTH stimulation test (measure steroid hormone precursors)

#### Functional Adrenomedullary Tumor

##### Epinephrine-Secreting Tumor

Pheochromocytosis (dog, rarely cat)  
Diagnosis by exclusion, histopathology

## **Cretinism (Hypothyroidism in Puppies)**

### **Clinical Findings**

Dwarfism  
Short, broad skull with short, thick neck  
Enlarged cranium  
Shortened limbs  
Shortened mandible  
Mental dullness  
Alopecia  
Retention of puppy coat  
Kyphosis  
Inappetence  
Hypothermia  
Constipation  
Gait abnormalities  
Delayed dental eruption  
Macroglossia  
Dry coat  
Thick skin  
Lethargy  
Dyspnea  
Goiter

# Diabetes Insipidus

## Differential Diagnosis

Features of diabetes insipidus include polyuria, polydipsia, and a near-continuous demand for water. Only the following three disorders can cause the degree of polyuria and dilute urine seen with diabetes insipidus:

- Central diabetes insipidus
- Nephrogenic diabetes insipidus
- Primary polydipsia

## Causes in Dogs and Cats

### Central Diabetes Insipidus

Idiopathic

Traumatic

Neoplasia

- Primary pituitary neoplasm
- Meningioma
- Craniopharyngioma
- Chromophobe adenoma
- Chromophobe adenocarcinoma
- Metastatic neoplasia

Pituitary and hypothalamic malformation

Cysts

Inflammation

Parasitic lesions

Complication of pituitary surgery (hypophysectomy)

Familial?

### Nephrogenic Diabetes Insipidus

*Polyuria caused by nonresponsiveness to antidiuretic hormone (ADH)*

Primary idiopathic

Primary familial (Husky)

Secondary acquired

- Renal insufficiency or failure
- Hyperadrenocorticism
- Hypoadrenocorticism
- Hepatic insufficiency
- Pyometra
- Hypercalcemia
- Hypokalemia
- Postobstructive diuresis
- Diabetes mellitus
- Normoglycemic glucosuria
- Hyperthyroidism
- Iatrogenic or drug induced
- Renal medullary solute washout

# Diabetic Ketoacidosis

## Clinical Findings

No signs may be seen early with diabetic ketoacidosis.

## Historical Findings

Lethargy  
Anorexia  
Vomiting

## Physical Examination Findings

Dehydration  
Depression  
Weakness  
Tachypnea  
Vomiting  
Acetone odor on breath  
Slow, deep breaths (secondary to metabolic acidosis)  
Abdominal pain/abdominal distension secondary to concurrent pancreatitis

## Clinicopathologic Findings

Hyperglycemia  
Neutrophilic leukocytosis  
Hemoconcentration  
Metabolic acidosis (decreased total carbon dioxide concentration)  
Hypercholesterolemia/lipemia  
Increased ALP  
Increased ALT  
Increased blood urea nitrogen (BUN)/creatinine  
Hyponatremia  
Hypochloremia  
Hypokalemia  
Increased amylase/lipase  
Hyperosmolality  
Glycosuria  
Ketonuria  
Urinary tract infection

# Diabetes Mellitus

## Potential Factors in Etiopathogenesis

Obesity

Pancreatitis

Immune-mediated insulinitis

Concurrent hormonal disease

- Hyperadrenocorticism
- Diestrus-induced excess of growth hormone
- Hypothyroidism

Genetics (dog, possibly cat)

Drugs

- Glucocorticoids
- Megestrol acetate (cat)

Infection

Concurrent illness

- Renal insufficiency
- Cardiac disease

Hyperlipidemia (dog, possibly cat)

Islet amyloidosis

## Clinicopathologic Abnormalities, Uncomplicated Diabetes Mellitus

### CBC

Often normal

Leukocytosis if pancreatitis or infection present

### Serum Chemistry

Hyperglycemia

Mild increase in ALP and ALT

Hypercholesterolemia/hypertriglyceridemia

### Urinalysis

Urine specific gravity normal to mildly decreased ( $> 1.025$ )

Glycosuria

Variable ketonuria

Bacteriuria

Proteinuria

### Ancillary Tests

Increased amylase/lipase if pancreatitis present

Normal serum trypsinlike immunoreactivity (TLI)

Low TLI with exocrine pancreatic insufficiency

High TLI with acute pancreatitis

Normal-to-high TLI with chronic pancreatitis

Low-to-normal serum insulin with insulin-dependent diabetes mellitus

Low, normal, or increased serum insulin with non-insulin-dependent diabetes mellitus

## Potential Complications

### Common

Iatrogenic hypoglycemia

Polyuria/polydipsia



Weight loss  
Cataracts (dog)  
Anterior uveitis  
Bacterial infections (especially urinary tract infection [UTI])  
Ketoacidosis  
Pancreatitis  
Peripheral neuropathy (cat)  
Hepatic lipidosis

### **Uncommon**

Peripheral neuropathy (dog)  
Glomerulopathy  
Glomerulosclerosis  
Retinopathy  
Exocrine pancreatic insufficiency  
Gastric paresis  
Diabetic diarrhea  
Diabetic dermatopathy

## **Causes of Insulin Resistance or Ineffectiveness in Dogs and Cats**

### **Caused by Insulin Therapy**

Improper administration  
Inadequate dose  
Inactive insulin  
Diluted insulin  
Somogyi effect  
Inappropriate insulin administration  
Impaired insulin absorption  
Antiinsulin antibody excess

### **Caused by Concurrent Disorder**

Obesity  
Diabetogenic drugs  
Hyperadrenocorticism  
Hypothyroidism (dog)  
Hyperthyroidism (cat)  
UTI  
Oral infections  
Chronic inflammation/pancreatitis  
Diestrus (bitch)  
Acromegaly (cat)  
Renal insufficiency  
Hepatic insufficiency  
Cardiac insufficiency  
Glucagonoma  
Pheochromocytoma  
Exocrine pancreatic insufficiency  
Hyperlipidemia  
Neoplasia

## **Clinical Findings Associated with Insulin-Secreting Tumors**

Seizures  
Weakness  
Collapse  
Ataxia

Polyphagia  
Weight gain  
Muscle fasciculations  
Posterior weakness (neuropathy)  
Lethargy  
Nervousness  
Unusual behavior

# Gastrinoma (Zollinger–Ellison Syndrome)

## Clinical Findings

### Clinical Signs

Vomiting  
Weight loss  
Anorexia  
Diarrhea  
Gastric and duodenal ulceration  
Hematochezia  
Hematemesis  
Melena  
Obstipation  
Lethargy/depression  
Abdominal pain  
Esophageal pain and ulceration  
Regurgitation  
Fever  
Polydipsia  
Thin body condition  
Pallor

### Clinicopathologic Findings

Regenerative anemia  
Hypoproteinemia  
Neutrophilic leukocytosis  
Hypoalbuminemia  
Hypocalcemia  
Mild increases in hepatic enzymes  
Hypochloremia  
Hypokalemia  
Hyponatremia  
Metabolic acidosis  
Metabolic acidosis (secondary to vomiting)  
Hyperglycemia, hypoglycemia (uncommon)

# Glucagonoma

## Clinical Findings in Dogs

### Clinical Signs

Necrolytic migratory erythema (crusting skin rash of elbows, hocks, nose, scrotum, flank, ventral abdomen, distal extremities, and mucocutaneous junctions of mouth, eyes, prepuce and vulva)  
Footpad lesions  
Glucose intolerance/diabetes mellitus (caused by excess glycogenolysis and gluconeogenesis)  
Oral ulcerations  
Lethargy  
Weight loss  
Decreased appetite  
Muscle atrophy  
Peripheral lymphadenopathy

### Clinicopathologic Findings

Hyperglycemia  
Nonregenerative anemia  
Increased hepatic enzymes  
Decreased albumin  
Decreased globulin  
Decreased BUN  
Decreased cholesterol  
Glucosuria  
Abdominal ultrasound lesions

- Increased echogenicity of portal and hepatic vein walls
- Diffuse hyperechogenicity
- Multiple small hypoechoic foci

# Hyperadrenocorticism

## Clinical Findings

### Potential Clinical Signs

Polyuria/polydipsia  
Alopecia  
Pendulous abdomen  
Hepatomegaly  
Polyphagia  
Muscle weakness  
Muscle atrophy  
Pyoderma  
Comedones  
Panting  
Pacing/restlessness  
Hyperpigmentation  
Systemic hypertension  
Testicular atrophy  
Anestrus  
Calcinosis cutis  
Facial nerve paralysis  
Pulmonary thromboembolism

### Potential Clinicopathologic Findings

UTI/pyelonephritis  
Decreased urine specific gravity  
Increased serum ALP  
Increased ALT  
Hypercholesterolemia  
Hypertriglyceridemia  
Hyperglycemia (mild to moderate)  
Diabetes mellitus (uncommon)  
Increased serum bile acids  
Decreased BUN and creatinine (secondary to diuresis)  
Hypophosphatemia  
Stress leukogram

- Neutrophilia
- Lymphopenia
- Eosinopenia
- Monocytosis

Thrombocytosis  
Mild erythrocytosis  
Decreased total serum thyroxine ( $T_4$ ) or free  $T_4$   
Urolithiasis

# Hyperglycemia

## Differential Diagnosis

Diabetes mellitus

Stress (physiologic in cat)

Hyperadrenocorticism

Drug therapy

- Glucocorticoids
- Progestogens
- Megestrol acetate
- Thiazide diuretics

Dextrose-containing fluids

Parenteral nutrition

Postprandial effect (diets containing monosaccharides, disaccharides, propylene glycol)

Exocrine pancreatic neoplasia

Pancreatitis

Renal insufficiency

Acromegaly (cat)

Pheochromocytoma (dog)

Diestrus (bitch)

Head trauma

# Hypoadrenocorticism

## Potential Clinical Findings

### Clinical Signs

Lethargy/depression  
Episodic weakness  
Vomiting  
Anorexia  
Waxing and waning illness  
Weight loss/failure to gain weight  
Bradycardia  
Dehydration/hypovolemia  
Diarrhea  
Polyuria or polydipsia  
Collapse  
Syncope  
Restlessness/shaking/shivering  
Regurgitation  
Muscle cramping  
GI hemorrhage/melena  
Abdominal pain

### Potential Clinicopathologic Findings

Hyponatremia  
Hyperkalemia  
Hypochloremia  
Decreased sodium/potassium ratio (< 24:1)  
Azotemia

- Increased BUN
- Increased creatinine
- Increased phosphate

Decreased bicarbonate and total CO<sub>2</sub> concentrations  
Hypercalcemia  
Hypoglycemia  
Hypoalbuminemia  
Increased hepatic enzymes  
Metabolic acidosis  
Lymphocytosis  
Eosinophilia  
Relative neutropenia  
Anemia (usually nonregenerative)  
Variable urine specific gravity (< 1.030)

# Hypoglycemia

## Differential Diagnosis

### Excess Secretion of Insulin or Insulin-Like Factors

Insulinoma (beta-cell tumor)

Extrapaneatic tumor (hepatocellular carcinoma, hepatoma, leiomyosarcoma, leiomyoma)

Islet cell hyperplasia

### Decreased Glucose Production

Toy breeds

Neonates

Hunting dog hypoglycemia

Malnutrition

Pregnancy

Fasting/starvation

Hypoadrenocorticism

Hypopituitarism

Growth hormone deficiency

Liver disease (portal caval shunt, chronic fibrosis/cirrhosis)

Glycogen storage diseases

### Excess Glucose Consumption

Sepsis

Extreme exercise

Severe erythrocytosis

### Drug-Associated Causes

Insulin

Oral hypoglycemics

Ethanol, ethylene glycol

Many other drugs reported to cause hypoglycemia in humans

### Spurious

Blood cells not promptly separated from serum

Glucometers, laboratory error



# Hyponatremia/hyperkalemia

## Differential Diagnosis

### Hypoadrenocorticism

### Renal or Urinary Tract Disease

Urethral obstruction  
Acute renal failure  
Chronic oliguric or anuric renal failure  
Postobstructive diuresis  
Nephrotic syndrome

### Severe GI Disease

Parasitic infestation

- Whipworm (trichuriasis)
- Roundworm (ascariasis)
- Hookworm (ancylostomiasis)

Salmonellosis  
Viral enteritis

- Parvovirus
- Canine distemper virus

Gastric dilatation/volvulus  
GI perforation  
Severe malabsorption  
Hemorrhagic gastroenteritis  
Pancreatic disease

### Severe Hepatic Failure

Cirrhosis  
Neoplasia

### Severe Metabolic or Respiratory Acidosis

### Congestive Heart Failure

### Massive Release of Potassium into Extracellular Fluid

Crush injury  
Aortic thrombosis  
Rhabdomyolysis

- Heat stroke
- Exertional

Massive sepsis  
Massive hemolysis

### Pleural Effusion

### Pregnancy

### Lymphangiosarcoma

### Pseudohyperkalemia

Akitas and related breeds  
Severe leukocytosis ( $> 100,000/\text{mm}^3$ )  
Severe thrombocytosis ( $> 1 \text{ million}/\text{mm}^3$ )

**Diabetes Mellitus**

**Primary Polydipsia**

**Inappropriate ADH Secretion**

**Drug Induced**

Potassium-sparing diuretics

Nonsteroidal antiinflammatory drugs (NSAIDs)

Angiotensin-converting enzyme (ACE) inhibitors

Potassium-containing fluids

## Insulinoma

### Differential Diagnosis for Insulin-Secreting B-Cell Neoplasia

#### Excess Insulin or Insulin-Like Factors

Insulinoma  
Extrapaneacretic tumor  
Islet cell hyperplasia

#### Decreased Glucose Production

Hypoadrenocorticism  
Hypopituitarism  
Growth hormone deficiency  
Liver disease  
Glycogen storage diseases  
Neonates  
Toy breeds  
Fasting  
Malnutrition  
Pregnancy  
Uremia

#### Excess Glucose Consumption

Sepsis  
Extreme exercise

#### Drug-Associated Causes

Insulin  
Oral hypoglycemics (sulfonylurea)  
Salicylates (e.g., aspirin)  
Acetaminophen  
beta-blockers  
beta<sub>2</sub>-agonists  
Ethanol  
Xylitol  
Monoamine oxidase inhibitors  
Tricyclic antidepressants  
ACE inhibitors  
Antibiotics (e.g., tetracycline)  
Lidocaine overdose  
Lithium

#### Factitious Hypoglycemia

Failure to separate blood cells from serum promptly  
Severe polycythemia or leukocytosis when serum separation delayed

## Parathyroidism

### Hyperparathyroidism, Primary—Clinical Findings

#### Clinical Signs

Polyuria/polydipsia  
Weight loss  
Anorexia  
Lethargy, listlessness  
UTI  
Urolithiasis  
Vomiting  
Constipation  
Mental dullness, obtundation, coma  
Weakness, muscle wasting, shivering

#### Clinicopathologic Findings

Hypercalcemia  
Increased ionized calcemia  
Low normal-to-low serum phosphorus  
Decreased urine specific gravity  
Hematuria  
Pyuria  
Crystalluria  
Bacteriuria

### Hypoparathyroidism—Clinical Findings

#### Clinical Signs

Seizures  
Facial rubbing, biting at feet  
Splinted abdomen  
Stiff gait  
Intermittent lameness  
Muscle fasciculations, cramping, tremors  
Fever  
Paroxysmal tachyarrhythmias  
Muffled heart sounds  
Weak pulses  
Disorientation  
Behavioral changes (restless, nervous, anxious, aggressive)

#### Clinicopathologic Findings

Hypocalcemia  
Hyperphosphatemia  
Decreased serum parathyroid hormone concentration

#### Electrocardiographic Findings

Deep, wide T waves  
Prolonged QT interval  
Bradycardia



# Pheochromocytoma

## Clinical Findings

Intermittent weakness  
Intermittent collapse  
Panting  
Tachypnea  
Seizures  
Acute blindness  
Tachycardia  
Lethargy  
Inappetence  
Cardiac arrhythmias  
Restlessness  
Exercise intolerance  
Panting/tachypnea  
Weak pulses  
Vomiting  
Diarrhea  
Weight loss  
Muscle wasting  
Polyuria/polydipsia  
Abdominal distension  
Rear limb edema  
Pale mucous membranes  
Abdominal pain  
Hemorrhage (epistaxis, surgical incision sites)  
Palpable abdominal mass  
Sudden death

# Pituitary Dwarfism

## Clinical Findings

### Musculoskeletal Signs

Stunted growth  
Delayed growth plate closure  
Thin skeleton  
Immature facial features  
Square, chunky contour as adult  
Bone deformities  
Delayed dental eruption

### Dermatologic Signs

Soft, woolly hair coat  
Lack of guard hairs  
Alopecia (bilaterally symmetric trunk, neck, and proximal extremities)  
Hyperpigmentation  
Thin, fragile skin  
Wrinkles  
Scales  
Comedones  
Papules  
Pyoderma  
Seborrhea sicca  
Retention of secondary hairs

### Reproductive Signs

Testicular atrophy  
Unilateral or bilateral cryptorchidism  
Flaccid penile sheath  
Failure to have estrous cycles

### Other Signs

Mental dullness  
Shrill, puppylike bark  
Signs of secondary hypothyroidism  
Signs of secondary adrenal insufficiency

# Thyroid Disease

## Hyperthyroidism, Feline—Clinical Findings

### Clinical Signs

Weight loss/thin body condition  
Polyphagia  
Hyperactivity  
Palpable thyroid nodule (goiter)  
Tachycardia  
Vomiting  
Cardiac murmur  
Premature beats  
Gallop rhythm  
Aggressiveness  
Panting  
Pacing  
Restlessness  
Increased nail growth  
Alopecia  
Polyuria/polydipsia  
Diarrhea  
Increased fecal volume  
Muscle weakness  
CHF  
Dyspnea  
Retinal lesions (tortuous blood vessels retinal tears, retinal detachment)  
Ventroflexion of neck  
Unkempt coat/alopecia  
Tremor  
Weakness  
Anorexia  
Heat avoidance

## Hypothyroidism, Canine—Clinical Findings

### Clinical Signs

Lethargy/exercise intolerance  
Weight gain  
Cold intolerance  
Mental dullness  
Dermatologic signs

- Alopecia
- Superficial pyoderma
- Seborrhea sicca or oleosa
- Dry, scaly skin
- Changes in hair coat quality and color
- Hyperkeratosis
- Hyperpigmentation
- Comedones
- Hypertrichosis
- Ceruminous otitis
- Myxedema (cutaneous mucinosis)
- Poor wound healing
- Slow regrowth of hair

Reproductive abnormalities



- Male: decreased libido, testicular atrophy, hypospermia
- Female: delayed estrus, silent estrus, failure to cycle, abortion, small litters, uterine inertia, weak or stillborn puppies

Peripheral neuropathies

- Generalized peripheral neuropathies
- Specific peripheral neuropathies (especially cranial nerves [CNs], facial, trigeminal, vestibulocochlear)

Cerebral dysfunction (myxedema coma [rare])

Cardiovascular signs

- Sinus bradycardia, weak apex beat, low QRS voltages, inverted T waves, hypercholesterolemia leading to atherosclerosis (rare)

Ocular abnormalities (corneal lipidosis, corneal ulceration, uveitis, secondary glaucoma, lipemia retinalis, retinal detachment, and keratoconjunctivitis sicca reported, but causal relationship not proven)

### **Clinicopathologic Changes**

Nonregenerative anemia

Hypercholesterolemia

Hypertriglyceridemia

Mild increases in hepatic enzymes

---

## **SECTION IV**

# Gastroenterologic Disorders

---

Chronic Constipation, Feline  
Dental and Oral Cavity Diseases  
Diarrhea  
Diseases of the Tongue  
Esophageal Disease  
Fecal Incontinence  
Ileus  
Large Intestinal Disease  
Malabsorptive Disease  
Perianal Disease  
Protein-Losing Enteropathy  
Salivary Gland Disease  
Small Intestinal Disease  
Stomach Disorders  
Tonsillar Disorders

# Chronic Constipation, Feline

## Differential Diagnosis

### Neuromuscular Dysfunction

- Colonic smooth muscle: idiopathic megacolon, aging
- Spinal cord disease: lumbosacral disease, cauda equina syndrome, sacral spinal cord deformities (Manx cat)
- Hypogastric or pelvic nerve disorders: traumatic injury, malignancy, dysautonomia

### Mechanical Obstruction

- Intraluminal: foreign material, neoplasia, rectal diverticula, perineal hernia, anorectal strictures
- Intramural: neoplasia
- Extraluminal: pelvic fractures, neoplasia

### Inflammation

- Perianal fistula, proctitis, anal sac abscess, anorectal foreign bodies, perianal bite wounds

### Metabolic and Endocrine

- Metabolic: dehydration, hypokalemia, hypercalcemia
- Endocrine: hypothyroidism, obesity, nutritional secondary hyperparathyroidism

### Environmental and Behavioral

- Soiled litter box, inactivity, hospitalization, change in environment

# Dental and Oral Cavity Diseases

## Differential Diagnosis

### Trauma

Fractures

- Crown
- Root
- Mandible
- Maxilla

Avulsion

Pulp injury

Temporomandibular luxation

### Caries

### Feline Dental Resorptive Lesions

### Periodontal Disease

Gingivitis

Gingival recession

Bone loss, osteomyelitis

Tooth loss

### Tooth Root Abscess

### Oronasal Fistula

### Stomatitis (Faucitis, Glossitis, Pharyngitis)

FIV, FeLV, feline syncytium-forming virus

Feline calicivirus, feline herpesvirus, FIP

Candidiasis

Uremia

Trauma (foreign objects, caustic agents, electric cord bite)

Autoimmune disease (pemphigus, lupus, idiopathic vasculitis, toxic epidermal necrolysis)

Feline idiopathic gingivitis/pharyngitis

### Neoplasia

#### Malignant

Fibrosarcoma

Squamous cell carcinoma

Melanoma

Salivary gland neoplasms

#### Benign

Epulis

- Fibromatous
- Acanthomatous
- Ossifying

Papilloma

Fibroma

Lipoma

Chondroma

Osteoma

Hemangioma  
Hemangiopericytoma  
Histiocytoma

### **Eosinophilic Granuloma Complex**

Linear granuloma  
Eosinophilic ulcer (usually on maxillary lips)

### **Sialocele**

# Diarrhea

## Causes of Diarrhea

### GI Disease

- Diffuse GI disease (e.g., inflammation or lymphoma)
- Gastric disease (achlorhydria, dumping syndromes)
- Intestinal disease (primary small intestinal disease, primary large intestinal disease, dietary induced such as food poisoning, gluttony, or sudden change of diet)

### Nongastrointestinal Disease

- Pancreatic disease (exocrine pancreatic insufficiency, pancreatitis, pancreatic carcinoma, gastrinoma or Zollinger–Ellison syndrome)
- Liver disease (hepatocellular failure, intrahepatic and extrahepatic cholestasis)
- Endocrine disease (classical hypoadrenocorticism, atypical hypoadrenocorticism, hyperthyroidism, hypothyroidism)
- Renal disease (uremia, nephrotic syndrome)
- Polysystemic infection (e.g., distemper, leptospirosis, infectious canine hepatitis in dogs, FIP, FeLV, FIV in cats)
- Miscellaneous (toxemias such as pyometra and peritonitis, CHF, autoimmune disease, metastatic neoplasia, various toxins and drugs)

## Classification of Diarrhea

### Mechanistic

- Secretory
- Osmotic
- Permeability (exudative)
- Dysmotility
- Mixed

### Temporal

- Acute
- Chronic

### Anatomic

- Extraintestinal
- Small intestinal
- Large intestinal
- Diffuse

### Pathophysiologic

- Biochemical
- Allergic
- Inflammatory
- Neoplastic

### Etiologic

- Bacteria
- Dietary
- Fungal
- Idiopathic
- Parasitic
- Viral

### **Causal**

- Exocrine pancreatic insufficiency, salmonellosis, lymphoma, other

### **Clinical**

- Acute, nonfatal, mild, self-limiting
- Acute, severe potentially fatal
- Acute systemic disease
- Chronic
- Chronic protein-losing

## **Differentiation of Small Intestinal Diarrhea from Large Intestinal Diarrhea**

### **Small intestinal diarrhea signs**

- Weight loss with chronicity
- Polyphagia sometimes
- Normal to slightly increased frequency of bowel movements
- Volume of feces often increased
- Rare blood in feces (melena)
- Rare mucus in feces
- Tenesmus is uncommon to absent
- Concurrent vomiting may be seen

### **Large intestinal diarrhea signs**

- Weight loss uncommon
- Polyphagia rare to absent
- Frequency of bowel movements is often greatly increased but may be normal
- Usually decreased due to increased frequency
- Sometimes (hematochezia)
- Sometimes mucus in feces
- Tenesmus often present
- Concurrent vomiting unlikely

# Diseases of the Tongue

## Differential Diagnosis

### Trauma

- Mechanical injury (sharp objects)
- Chemical injury
- Electric shock (electric cord)
- Foreign body (plant material, porcupine quill, linear foreign bodies)
- Sublingual hyperplastic tissue (gum chewer's disease)

### Viral

- Calicivirus
- Herpesvirus
- Papillomavirus

### Neoplasia

- Malignant melanoma
- Squamous cell carcinoma
- Benign tumors (lipoma, plasma cell tumor, granular cell tumors, fibroma)

### Metabolic Disease (Uremia)

### Sublingual Mucocele (Ranula)

### Immune Mediated

- Mucous membrane pemphigoid
- Pemphigus vulgaris
- Bullous pemphigoid
- SLE
- Autoimmune vasculopathies (idiopathic, infectious, food allergies, drug reaction, neoplasia)

### Eosinophilic granulomas

### Contact Mucosal Ulceration from Calculus Contact

### Calcinosis Circumscripta



# Esophageal Disease

## Differential Diagnosis

### Congenital

#### Obstruction

Persistent right aortic arch  
Persistent right or left subclavian artery  
Other vascular ring anomaly

#### Idiopathic

### Acquired

#### Obstruction

Foreign body  
Cicatrix/stricture  
Neoplasia

- Carcinoma
- *Spirocerca lupi*-induced sarcoma
- Leiomyoma of lower esophageal sphincter
- Extraesophageal neoplasia
  - Thyroid carcinoma
  - Pulmonary carcinoma
  - Mediastinal lymphosarcoma

Achalasia of lower esophageal sphincter (rare)  
Gastroesophageal intussusception (rare)

#### Weakness

Myasthenia (generalized or localized)  
Hypoadrenocorticism  
Esophagitis  
Persistent vomiting  
Hiatal hernia  
Gastroesophageal reflux/anesthesia-associated reflux  
Caustic ingestion (doxycycline, disinfectants, chemicals, etc.)  
Foreign body  
Excess gastric acidity (gastrinoma, mast cell tumor [MCT])  
Fungal organisms (e.g., pythiosis)

### *Spirocerca lupi* Infection

### Myopathies/Neuropathies

Hypothyroidism  
SLE  
Others

### Miscellaneous Causes

Lead poisoning  
Chagas disease  
Canine distemper  
Dermatomyositis (principally in Collies)  
Dysautonomia  
Tetanus

**Idiopathic**

# Fecal Incontinence

## Causes

### Nonneurologic Disease

#### Colorectal Disease

Inflammatory bowel disease  
Neoplasia  
Constipation

#### Anorectal Disease

Perianal fistula  
Neoplasia  
Surgery (anal saccullectomy, perianal herniorrhaphy, rectal resection and anastomosis)

#### Miscellaneous

Decreased mentation  
Old age  
Severe diarrhea  
Irritable bowel disease

### Neurologic Disease

#### Sacral Spinal Cord Disease

Diskospondylitis  
Neoplasia  
Degenerative myelopathy  
Congenital vertebral malformation  
Sacroccygeal hypoplasia of Manx cats  
Sacral fracture  
Sacroccygeal subluxation  
Lumbosacral instability  
Lumbosacral nerve root compression  
Meningomyelocele  
Viral meningomyelitis  
Cauda equina syndrome  
Vertebral fracture

#### Peripheral Neuropathy

Trauma  
Penetrating wounds  
Repair of perineal hernia  
Perineal urethrostomy  
Hypothyroidism?  
Diabetes mellitus?  
Dysautonomia

#### Central Nervous System

Infectious (distemper, FIP)  
Neoplasia  
Vascular compromise



# Ileus

## Causes

### Physical

Intestinal obstruction (foreign body, intussusception, neoplasia, granuloma, torsion, volvulus, incarceration in hernia, adhesions)  
Overdistension by aerophagia

### Metabolic

Uremia  
Diabetes mellitus  
Hypokalemia  
Endotoxemia

### Inflammatory

Parvovirus  
Peritonitis  
Bacterial enteritis  
Other inflammatory causes

### Functional

Abdominal surgery  
Peritonitis  
Pancreatitis  
Ischemia

### Neuromuscular

Anticholinergic drugs  
Spinal cord injury  
Visceral myopathies/neuropathy  
Dysautonomia

# Large Intestinal Disease

## Differential Diagnosis

### Inflammation of Large Intestine

Acute colitis/proctitis

Chronic colitis

- Lymphocytic/plasmacytic colitis
- Eosinophilic enterocolitis
- Chronic ulcerative colitis
- Histiocytic ulcerative colitis (Boxers)

Irritable bowel syndrome

### Dietary Intolerance or Food Allergy

### Parasites

Whipworms (*Trichuris* spp.)

*Tritrichomonas* spp. (cats)

Giardiasis

Hookworms (*Ancylostoma* spp.)

*Heterobilharzia americanum*

### Bacterial Colitis

Clostridial colitis

*Campylobacter* colitis

*Escherichia coli*

*Salmonella* spp.

*Brachyspira pilosicoli*

### Fungal Colitis

Histoplasmosis

Pythiosis

### Viral Colitis

FeLV

Infections secondary to FeLV and FIV

### Algae (*Prototheca* spp.)

### Cecocolic Intussusception

### Rectal Prolapse

### Neoplasms of Large Intestine

Adenocarcinoma

Lymphoma

Rectal polyps

### Pythiosis

### Constipation

Pelvic canal obstruction caused by malaligned healing of pelvic fractures

Benign rectal stricture

Dietary indiscretion leading to constipation

Idiopathic megacolon

# Malabsorptive Disease

## Causes

Dietary intolerance or allergy

Parasitism

- Giardiasis

Antibiotic-responsive enteropathy (dysbiosis)

Inflammatory bowel disease

- Lymphocytic/plasmacytic enteritis
- Eosinophilic enteritis
- Idiopathic villous atrophy
- Purulent enteritis

GI lymphoma

Lymphangiectasia

Obstruction caused by neoplasia, infection, or inflammation

Portal hypertension

Pythiosis

Exocrine pancreatic insufficiency

Cholestatic liver disease/biliary obstruction

Brush border enzyme deficiencies

Brush border transport protein deficiencies

Hyperthyroidism

Gastric hypersecretion

Granulomatous enteritis/gastritis



## Perianal Disease

### Differential Diagnosis

Perineal hernia

Perianal fistulae

Anal sacculitis

Anal sac impaction

Abscessed anal sac

Anal sac (apocrine gland) adenocarcinoma

Perianal gland tumors

- Adenoma (common)
- Adenosarcoma (rare)

# Protein-Losing Enteropathy

## Differential Diagnosis

### GI Hemorrhage

Hemorrhagic gastroenteritis  
Ulceration  
Neoplasia

### Endoparasites

*Giardia* spp.  
*Ancylostoma* spp.  
*Trichuris* spp.  
Coccidia  
Others

### Inflammation

Lymphocytic/plasmacytic  
Eosinophilic  
Granulomatous

### Infection

Parvovirus  
Salmonellosis  
Histoplasmosis  
Phycomycosis

### Structural

Intussusception

### Neoplasia

Lymphosarcoma

### Lymphangiectasia

Primary lymphatic disorder  
Venous hypertension (e.g., right heart failure)  
Hepatic cirrhosis

# Salivary Gland Disease

## Differential Diagnosis

### Salivary Neoplasia (more common in cats than dogs)

- Adenocarcinoma
- Squamous cell carcinoma
- Undifferentiated sarcoma
- Mucoepidermoid tumor
- Malignant mixed tumor
- Sarcoma
- Acinic cell carcinoma
- Adenoid cystic carcinoma

### Salivary Mucocele

Sublingual gland most commonly

### Sialoadenitis

### Sialoadenosis

# Small Intestinal Disease

## Clinical Findings

Diarrhea  
Vomiting  
Inappetence/anorexia  
Malabsorption  
Protein-losing enteropathy  
Weight loss  
Dehydration  
Hematemesis  
Melena  
Polyphagia  
Coprophagia  
Abdominal distension  
Abdominal pain  
Borborygmus/flatulence  
Ascites  
Edema  
Shock  
Halitosis  
Polydipsia  
Ileus

## Differential Diagnosis

### Acute Diarrhea

Acute enteritis  
Dietary indiscretion  
Enterotoxemia

### Infectious Diarrhea

Canine parvoviral enteritis  
Clostridial disease  
Feline parvoviral enteritis (panleukopenia)  
Canine coronavirus enteritis  
Feline coronavirus enteritis  
FeLV-associated panleukopenia  
FIV-associated diarrhea  
Salmon poisoning (*Neorickettsia helminthoeca*)  
Campylobacteriosis  
Salmonellosis  
Histoplasmosis  
Miscellaneous bacteria (*Yersinia enterocolitica*, *Aeromonas hydrophila*, *Plesiomonas shigelloides*)  
Protothecosis (algae)

### Alimentary Tract Parasites

Roundworms (*Toxocara* spp.)  
Hookworms (*Ancylostoma*, *Uncinaria* spp.)  
Tapeworms (*Dipylidium caninum*, *Taenia* spp., *Mesocystoides* spp.)  
*Strongyloides stercoralis* (in puppies)  
Coccidiosis  
Cryptosporidia  
Giardiasis  
Trichomoniasis

Tritrichomoniasis (feline)  
*Heterobilharzia*

### **Maldigestive Disease**

Exocrine pancreatic insufficiency

### **Malabsorptive Disease**

Dietary-responsive disease (allergy, intolerance)  
Inflammatory bowel disease (lymphocytic/plasmacytic enteritis canine eosinophilic gastroenteritis)  
Feline eosinophilic enteritis/hypereosinophilic syndrome  
Granulomatous enteritis  
Immunoproliferative enteropathy in Basenjis  
Enteropathy in Shar-Peis  
Antibiotic-responsive enteropathy

### **Protein-Losing Enteropathy**

Intestinal lymphangiectasia  
Protein-losing enteropathy in Soft-Coated Wheaten Terriers

### **Irritable Bowel Syndrome**

### **Intestinal Obstruction**

Simple intestinal obstruction  
Incarcerated intestinal obstruction  
Mesenteric torsion/volvulus  
Linear foreign object

### **Intussusception**

Ileocolic  
Jejunojunal

### **Short-Bowel Syndrome**

### **Neoplasia**

Alimentary lymphoma  
Intestinal adenocarcinoma  
Intestinal leiomyoma/leiomyosarcoma

## **Breed Susceptibilities, Dogs**

Basenji: lymphocytic/plasmacytic enteritis (immunoproliferative disease)  
Beagle: cobalamin deficiency  
Border Collie: cobalamin deficiency  
German Shepherd: idiopathic antibiotic-responsive small intestinal disease, inflammatory bowel disease (lymphoplasmacytic, eosinophilic)  
Giant Schnauzer: defective cobalamin absorption  
Irish Setter: gluten-sensitive enteropathy  
Lundehund: lymphangiectasia  
Retrievers: dietary allergy  
Rottweiler: increased susceptibility to parvoviral enteritis  
Soft-Coated Wheaten Terrier: protein-losing enteropathy/nephropathy  
Shar-Pei: lymphocytic/plasmacytic enteritis, cobalamin deficiency  
Yorkshire Terrier: lymphangiectasia  
Toy breeds: hemorrhagic gastroenteritis



# Stomach Disorders

## Differential Diagnosis

### Gastritis

#### Acute Gastritis

Dietary indiscretion  
Dietary intolerance or allergy  
Foreign body  
Drugs and toxins (NSAIDs, corticosteroids, antibiotics, plants, cleaners, bleach, heavy metals)  
Systemic disease (uremia, hepatic disease, hypoadrenocorticism)  
Parasites (*Ollulanus* spp., *Physaloptera* spp.)  
Bacterial (bacterial toxins, *Helicobacter* spp.)

#### Hemorrhagic Gastroenteritis

#### Chronic Gastritis

Lymphocytic/plasmacytic gastritis (inflammatory reaction to a variety of antigens such as *Helicobacter* spp. or *Physaloptera rara*)  
Eosinophilic gastritis (allergic reactions to food antigens)  
Granulomatous gastritis (e.g., *Ollulanus tricuspis*)  
Atrophic gastritis

### Gastric Outflow Obstruction/Gastric Stasis

Benign muscular pyloric hypertrophy (pyloric stenosis)  
Gastric antral mucosal hypertrophy  
Foreign body  
Idiopathic gastric hypomotility  
Bilious vomiting syndrome

### Gastric Ulceration/Erosion

#### Iatrogenic

NSAIDs  
Corticosteroids  
NSAID/corticosteroid combinations

#### Foreign Body

#### *Helicobacter* spp.

#### Stress Ulceration

Hypovolemic shock  
Septic shock  
After gastric dilatation/volvulus

- Neurogenic shock

Hyperacidity

- MCT
- Gastrinoma (rare)

Other causes

- Hepatic disease
- Renal disease
- Hypoadrenocorticism
- Inflammatory disease

## **Infiltrative Disease**

Neoplasia  
Inflammatory bowel disease  
Pythiosis (young dogs, southeastern United States)

## **Gastric Dilatation/Volvulus**

## **Causes of Acute Abdomen**

### **GI Causes**

Acute pancreatitis  
Gastroenteritis (parvoviral, bacterial, toxic, hemorrhagic gastroenteritis, etc.)  
Gastric dilatation/volvulus  
Intestinal obstruction/intussusception/volvulus/neoplasia  
Colitis  
Obstipation  
Necrosis, rupture, ulceration, or perforation of GI tract  
Surgical wound dehiscence  
Mesenteric torsion  
Duodenocolic ligament entrapment  
Pancreatic abscess  
Pancreatic neoplasia  
Dietary indiscretion

### **Hepatobiliary Causes**

Acute hepatitis/cholangiohepatitis/leptospirosis/intoxication  
Biliary obstruction  
Necrotizing cholecystitis  
Hepatic abscess  
Bile peritonitis  
Liver lobe torsion  
Hepatic trauma/rupture  
Hepatobiliary neoplasia

### **Urogenital Causes**

Urethral or ureteral obstruction/rupture  
Pyelonephritis  
Renal neoplasia  
Acute nephrosis/nephritis  
Cystic, renal, ureteral, or urethral calculi  
Prostatitis/prostatic abscess/prostatic cyst/prostatic neoplasia  
Dystocia  
Pyometra/uterine rupture  
Acute metritis  
Renal abscess  
Testicular torsion  
Ovarian cyst, ovarian neoplasia  
Uterine torsion  
Uroabdomen  
Vaginal rupture

### **Other Causes**

Penetrating wound, crush injury  
Peritonitis (septic, chemical, urine, bile)  
Mesenteric traction (large masses)/lymphadenitis/lymphadenopathy/volvulus/avulsion/artery thrombosis



Hemoabdomen (parenchymatous organ rupture)  
Neoplasia  
Splenic torsion/abscess/mass/rupture  
Strangulated hernia  
Adhesions with organ entrapment  
Pansteatitis  
Retroperitoneal hemorrhage  
Evisceration  
Surgical contamination

## Tonsillar Disorders

### Differential diagnosis of tonsillar disease

- Primary viral tonsillitis (bilaterally symmetrical enlargement, clinical signs of underlying disease seen such as ocular signs, nasal discharge, sneezing)
- Primary bacterial tonsillitis (bilaterally symmetrical enlargement, may cough if *Bordetella bronchiseptica*, culture to confirm)
- Secondary tonsillitis (bilaterally symmetrical disease)
  1. Coughing, vomiting, regurgitation due to concurrent disease
  2. Palate disorder (cleft or elongated)
  3. Periodontal disease
  4. Licking at pyoderma or inflamed anal sacs
- Foreign body (unilateral enlargement)
  1. Grass awn
  2. Splinter
  3. Bone fragment
  4. Porcupine quill
- Squamous cell carcinoma (unilateral enlargement, biopsy to confirm)
- Lymphoma (bilateral enlarged, often other lymphoid organs affected such as lymph nodes or spleen, could biopsy but aspiration of lymph nodes usually easier)
- Tonsillar cyst (unilateral enlargement, fluctuant, fluid filled)

---

## SECTION V

# Hematologic Disorders

---

Anemia

Coagulopathies, Inherited and Acquired

Expected Hemostatic Test Results in Selected Diseases

Leukocyte Disorders

Platelet Dysfunction

Splenitis/Splenomegaly

Thrombocytopenia

# Anemia

## Hemolytic Anemia

### Causes/Triggers of Immune-Mediated Hemolytic Anemia

#### Infection

##### Viral

FeLV, FIV, FIP, chronic upper respiratory or GI disease

##### Bacterial

Leptospirosis, *Mycoplasma haemophilus* infection, salmonellosis, acute and chronic infections (e.g., abscess, pyometra, diskospondylitis)

##### Parasitic

Babesiosis, anaplasmosis, leishmaniasis, dirofilariasis, ehrlichiosis, *Ancylostoma caninum*, *Trichuris vulpis* infection, bartonellosis

#### Immune Disorders

SLE

Hypothyroidism

Primary and secondary immunodeficiencies

#### Drugs/Toxins

Vaccines

Sulfonamides

Methimazole

Procainamide

Cephalosporins

Penicillins

Propylthiouracil

Carprofen

Levamisole

Griseofulvin

Bee-sting envenomation

#### Oxidants

Acetaminophen

Phenothiazines

Vitamin K

Methylene blue

Methionine

Propylene glycol

#### Inflammation

Pancreatitis

Prostatitis/cystitis

#### Neoplasia

Leukemias

Lymphoma

Multiple myeloma

MCT

Splenic hemangioma

Solid tumors (soft tissue sarcomas, bronchoalveolar carcinoma)

### **Genetic Predisposition**

American Cocker Spaniel (most common breed), English Springer Spaniel, Old English Sheepdog, Irish Setter, Poodle, Dachshund, Alaskan Malamute, Schnauzer

### **Differentiating Blood Loss from Hemolytic Anemia**

#### **Blood Loss**

Serum or plasma protein concentration normal to low

Clinical evidence of hemorrhage

No icterus, hemoglobinemia, spherocytosis, hemosiderinuria, autoagglutination, splenomegaly, or red blood cell (RBC) changes

Negative direct Coombs test

#### **Hemolysis**

Serum or plasma protein concentration normal to high

Rarely clinical evidence of hemorrhage

Icterus common

Hemoglobinuria/hemoglobinemia

Spherocytosis

Hemosiderinuria

Autoagglutination sometimes seen

Direct Coombs test usually positive

Splenomegaly

RBC changes numerous

### **Nonregenerative Anemia**

#### **Differential Diagnosis**

##### **Anemia of Chronic Disease**

##### **Erythropoietin-Related Conditions**

Renal disease

Hypothyroidism

Hypoadrenocorticism

Panhypopituitarism

Growth hormone deficiency

Reduced oxygen requirement

Increased oxygen release

##### **Iron-Deficiency Anemia**

Chronic inflammation

Chronic hemorrhage

Dietary iron deficiency

##### **Marrow Disorders**

##### **Toxic Red Cell Aplasia**

Estrogen related

Phenylbutazone related

Lead poisoning

Other drugs

##### **Hyperestrogenism (iatrogenic, neoplastic)**

## **Infection**

FeLV

FIV

Parvovirus

Ehrlichiosis

Babesiosis

*Mycoplasma haemofelis*

Endotoxemia

## **Immunotherapy**

## **Myelofibrosis**

FeLV infection

Pyruvate kinase–deficiency anemia

Idiopathic

## **Myelophthisic Disease**

Acute leukemias

Chronic leukemias

Multiple myeloma

Lymphoma

Systemic mast cell disease

Malignant histiocytosis

Metastatic carcinoma

Histoplasmosis

## **Myelodysplasia**

Idiopathic

FeLV/FIV

Preleukemic syndrome

## **Pure Red Cell Aplasia**

## **Ineffective Erythropoiesis**

### **Macrocytic (rare)**

Intrinsic marrow disease

Vitamin B<sub>12</sub> deficiency

Folic acid deficiency

### **Normocytic**

### **Myelofibrosis**

### **Intrinsic erythroid disease**

### **Microcytic**

Iron deficiency

Globin or porphyrin deficiency

### **Time Related**

Hemolysis or hemorrhage (during the first 3-5 days)

## **Diagnosis**

## **Nonregenerative Anemias without Other Cytopenias**

Examine bone marrow

### **Severe Erythroid Hypoplasia**

Pure red cell aplasia

### **Normal to Mild Erythroid Hypoplasia**

Inflammatory disease

Renal disease

Neoplasia

Hepatic disease

Hypothyroidism

Hypoadrenocorticism

### **Hypercellular Bone Marrow**

Less than 30% blast forms: consider myelodysplastic syndrome

Greater than 30% blast forms: consider hemopoietic neoplasia

### **Nonregenerative Anemias with Leukopenia and/or Thrombocytopenia**

Examine bone marrow.

### **Panhypoplasia**

Aplastic anemia

### **Disease Determined by Core Biopsy**

Myelonecrosis

Myelofibrosis

### **Hypercellular Bone Marrow**

Less than 30% blast forms: myelodysplastic syndrome

More than 30% blast forms: hemopoietic neoplasia

## **Regenerative Anemia**

### **Differential Diagnosis**

#### **Hemolysis**

Immune mediated

- Intravascular
- Extravascular

#### **Blood Loss Anemia**

Trauma

Coagulopathy

- Clotting factor deficiency
- DIC
- Platelet disorders
- Anticoagulant rodenticides

Endoparasites

GI blood loss

Severe ectoparasites (fleas)

#### **Oxidative Injury (Heinz body)**

Onion ingestion

Acetaminophen (cats)

Zinc ingestion (pennies minted after 1982, zinc oxide ointment, zinc-plated bolts and screws)

Benzocaine ingestion (dogs)

D-Methionine (cats)

Phenolic compounds (mothballs)



Phenazopyridine (cats)

### **Erythrocytic Parasites**

*Haemobartonella* spp.

*Babesia* spp.

*Cytauxzoon* spp.

### **Fragmentation (Microangiopathic)**

DIC

Heartworm disease

Hemangiosarcoma

Vasculitis

Hemolytic-uremic syndrome

Diabetes mellitus

### **Other**

Copper toxicity

Neonatal isoerythrolysis

Hereditary nonspherocytic hemolytic anemia

Pyruvate kinase deficiency

Feline porphyria

Hemolysis in Abyssinian and Somali cats

# Coagulopathies, Inherited and Acquired

## Differential Diagnosis

### Inherited Clotting Factor Deficiencies

Hemophilia A (factor VIII deficiency), (many breeds, especially German Shepherd, Golden Retriever, domestic short hair [DSH] cats)  
Hemophilia B (factor IX deficiency) (many breeds)  
Factor XII deficiency (Hageman trait) (miniature and standard Poodle, Shar-Pei, German Shorthaired Pointer, cats)  
Vitamin K–dependent factor deficiency: factors II, VII, IX, X (Devon Rex cats)  
Factor I: hypofibrinogenemia or dysfibrinogenemia (St. Bernard, Borzoi, Bichon Frise, Collie, DSH cats)  
Factor II: hypoprothrombinemia (Boxer, Otterhound, English Cocker Spaniel)  
Factor VII: hypoproconvertinemia (Beagle, Malamute, Boxer, Bulldog, Miniature Schnauzer, Scottish deerhound, DSH cats)  
Factor X deficiency (Cocker Spaniel, Parson Russell Terrier, DSH cats)  
Hemophilia C (factor XI deficiency: English Springer Spaniel, Great Pyrenees, Kerry Blue Terrier)  
Prekallikrein deficiency (Fletcher factor)

### Acquired Clotting Factor Deficiency

Liver disease

- Decreased clotting factor production
- Qualitative disorders

Cholestasis  
Vitamin K antagonists  
Autoimmune disease (lupus anticoagulant)  
DIC  
Neoplasia

## Clinical Manifestations of Primary and Secondary Hemostatic Defects

### Primary Hemostatic Defects

Thrombocytopenia and diseases that cause platelet dysfunction such as uremia, von Willebrand disease, monoclonal gammopathies, and vector-borne diseases—typically see manifestations of superficial bleeding

- Petechiae, ecchymoses
- Bleeding from mucosal surfaces (e.g., bleeding from gingiva, melena, hematochezia, epistaxis, hematuria)
- Bleeding in skin
- Hematomas rare
- Prolonged bleeding immediately after venipuncture

### Secondary Hemostatic Defects

Clotting factor deficiencies, rodenticide poisoning, liver disease—typically see manifestations of deep bleeding

- Petechiae, ecchymoses rare
- Hematomas common
- Bleeding into body cavities, joints, muscles
- Delayed bleeding after venipuncture



## Expected Hemostatic Test Results in Selected Diseases

- Thrombocytopenia—increased buccal mucosal bleeding time (BMBT), decreased platelet count (PLT), normal activated partial thromboplastin time (aPTT), normal prothrombin time (PT), normal fibrin degradation products (FDP)
- Platelet dysfunction (e.g., aspirin treatment)—increased BMBT, normal PLT, increased aPTT, normal PT, normal FDP
- Intrinsic pathway defect (e.g., hemophilia A or B)—normal BMBT, normal PLT, increased aPTT, normal PT, normal FDP
- Factor VII deficiency—normal BMBT, normal PLT, normal aPTT, increased PT, normal FDP
- Multiple factor defects (e.g., vitamin K antagonism)—normal BMBT, normal PLT, increased aPTT, increased PT, normal FDP
- Common pathway defect (e.g., factor X deficiency)—normal BMBT, normal PLT, increased aPTT, increased PT, normal FDP
- DIC—increased BMBT, decreased PLT, increased aPTT, increased PT, increased FDP
- von Willebrand disease—increased BMBT, normal PLT, normal aPTT, normal PT, normal FDP

# Leukocyte Disorders

## Differential Diagnosis

Pelger–Huët anomaly (many breeds of dogs and cats)

- Neutrophil function not altered

Chédiak–Higashi syndrome (blue smoke-colored Persian cats)

Canine leukocyte adhesion deficiency: fatal defect (Irish Setter and Irish Setter crosses)

Cyclic hemopoiesis (cyclic neutropenia): fatal defect (gray Collies)

Birman cat neutrophil granulation anomaly: neutrophil function not altered

Hypereosinophilic syndrome (cats): may eventually be fatal

Severe combined immunodeficiency of Parson Russell Terriers: fatal defect

Canine X-linked severe combined immunodeficiency: fatal defect (many breeds)

Defective neutrophil function in Doberman Pinscher: need frequent antimicrobial therapy

Immunodeficiency of Shar-Peis

Immunodeficiency of Weimaraners

Lysosomal storage diseases (many types described, all rare, many breeds)

# Platelet Dysfunction

## Differential Diagnosis

### Acquired Platelet Dysfunction

#### Drugs

Prostaglandin inhibitors (NSAIDs)

Vaccines

Antibiotics

Antifungals

Phenothiazines

Aminophylline

Diltiazem

Isoproterenol

Procainamide

Propranolol

Verapamil

Drugs that cause thrombocytopenia

- Cytotoxic drugs (azathioprine, chlorambucil, cyclophosphamide, doxorubicin)
- Miscellaneous (estrogen, methimazole)

#### Secondary to Disease

Renal disease

Liver disease

Myeloproliferative disorders

SLE

Dysproteinemias

#### Hereditary

von Willebrand disease (many breeds)

Canine thrombopathia (Basset Hound, Foxhound, Spitz)

Canine thrombasthenic thrombopathia (Otterhound, Great Pyrenees)

Collagen deficiency diseases/Ehlers–Danlos syndrome (many breeds)

# Splenitis/Splenomegaly

## Differential Diagnosis for Splenomegaly

### Splenic Mass (Asymmetric Splenomegaly)

Nodular hyperplasia (lymphoid, fibrohistiocytic)

Hematoma

Neoplasia

- Hemangiosarcoma
- Hemangioma
- Leiomyosarcoma
- Fibrosarcoma
- Histiocytic sarcoma
- Leiomyoma
- Myelolipoma
- Metastatic disease

Abscess

Extramedullary hematopoiesis

Granuloma

### Uniform Splenomegaly

#### Congestion

Drugs

Portal hypertension

Right-sided heart failure

Splenic torsion

#### Hyperplasia

Chronic infection

Inflammatory bowel disease

SLE

Polycythemia vera

#### Extramedullary Hematopoiesis

Chronic anemia

Immune-mediated hemolytic anemia

Immune-mediated thrombocytopenia

#### Neoplasia

Lymphoma

Systemic mastocytosis

Primary MCT

Metastatic neoplasia

Multiple myeloma

Acute and chronic leukemias

Malignant histiocytosis

Polycythemia vera

#### Nonneoplastic Infiltrative Disease

Amyloidosis

Hypereosinophilic syndrome (cats)

#### Inflammation

Suppurative  
Sepsis  
Bacterial endocarditis  
Infectious canine hepatitis  
Foreign body  
Penetrating wounds  
Toxoplasmosis

### **Granulomatous**

Cryptococcosis  
Histoplasmosis  
Mycobacteriosis  
Leishmaniasis

### **Pyogranulomatous**

FIP  
Blastomycosis  
Sporotrichosis

### **Eosinophilic**

Eosinophilic gastroenteritis  
Hypereosinophilic syndrome  
Neoplasia

### **Lymphoplasmacytic**

Ehrlichiosis  
Hemotropic mycoplasmosis  
Lymphoplasmacytic enteritis  
Pyometra  
Brucellosis  
Anaplasmosis

### **Necrotic Tissue**

Torsion  
Necrotic center of neoplasms  
Infectious canine hepatitis  
Anaerobic infection  
Systemic calicivirosis  
Tularemia  
Salmonellosis

## **Infectious Causes**

### **Viral**

FeLV  
FIV  
FIP  
Infectious canine hepatitis

### **Bacterial**

Canine brucellosis  
Mycoplasmosis  
Borreliosis  
Plague  
Tularemia  
Streptococcosis



Staphylococcosis  
Salmonellosis  
*Francisella* infection  
Endotoxemia

### **Fungal**

Cryptococcosis  
Histoplasmosis  
Blastomycosis

### **Rickettsial**

Ehrlichiosis  
Rocky Mountain spotted fever  
Q fever (*Coxiella burnetii*)  
*Mycoplasma haemofelis*

### **Protozoal**

Toxoplasmosis  
Cytauxzoonosis (cat)  
Babesiosis (*Babesia canis* and *B. gibsoni*)  
Leishmaniasis (dog)

# Thrombocytopenia

## Differential Diagnosis

### Increased Platelet Destruction/Sequestration/Utilization

Immune-mediated thrombocytopenia  
Drug-induced thrombocytopenia  
Infectious (*Anaplasma* spp., *Bartonella* spp., sepsis)  
Microangiopathy  
DIC  
Neoplasia (immune-mediated, microangiopathy)  
Live viral vaccine-induced thrombocytopenia  
Hemolytic uremic syndrome/thrombotic thrombocytopenic purpura  
Vasculitis  
Splenomegaly  
Splenic torsion  
Endotoxemia  
Acute hepatic necrosis  
Hemorrhage

### Decreased Platelet Production

Drug-induced megakaryocytic hypoplasia (estrogen, phenylbutazone, melphalan, lomustine, beta-lactams)  
Myelophthisis  
Idiopathic bone marrow aplasia  
Retroviral infection (FeLV/FIV)  
Immune-mediated megakaryocytic hypoplasia  
Cyclic thrombocytopenia  
Idiopathic bone marrow aplasia  
Ehrlichiosis

---

## SECTION VI

# Immunologic and Immune-Mediated Disorders

---

Autoimmune Skin Diseases

Immune-Mediated Disease

Immune System Components

Mechanisms of Immunopathologic Injury

Organ Systems Affected by Autoimmune Disorders in the Dog and Cat

Systemic Lupus Erythematosus

# Autoimmune Skin Diseases

## Differential Diagnosis

### Generalized Pustular/Crusting Dermatitis

Pemphigus foliaceus (PF) (nose, ear pinna, and footpad typically affected)  
Superficial pustular drug reactions (nasal and footpad lesions may be absent)  
Others: rare presentation—SLE, sterile eosinophilic pustulosis, linear immunoglobulin A (IgA) pustular dermatosis, subcorneal pustular dermatosis

### Focal Pustular/Crusting Dermatitis

Face, footpads: PF  
Face and ears only: PF (early), pemphigus erythematosus (PE), drug eruptions, lupus erythematosus  
Nasal only: DLE, PF (early), PE

### Mucocutaneous and Mucosal Ulcerations

Pemphigus vulgaris (may also have oral lesions)  
Mucous membrane bullous pemphigoid  
Epidermolysis bullosa acquisita  
EM (target lesions, cutaneous lesions)  
Bullous SLE  
Drug reactions  
Linear IgA bullous dermatosis, toxic epidermal necrolysis (rare)

### Nonmucosal Ulcerations (Axillae, Inguinae, Pinnae, Other HAIRY Areas)

Bullous pemphigoid  
Epidermolysis bullosa acquisita  
Linear IgA bullous dermatosis  
Bullous SLE  
Canine vesicular cutaneous lupus erythematosus (idiopathic ulcerative dermatosis of Collies, Shetland Sheepdogs)  
EM  
Toxic epidermal necrolysis  
Drug eruptions  
Pemphigus vulgaris

### Depigmenting Skin Diseases

Nasal only: DLE, vitiligo-like syndrome, uveodermatologic syndrome, early PF or PE  
Nose, footpad, lip, eyelid, mucocutaneous area: uveodermatologic syndrome (uveitis also)  
Hair coat or skin: idiopathic leukotrichia or leukoderma

### Miscellaneous

Focal alopecia: alopecia areata, rabies vaccine, focal vasculitis  
Widespread noninflammatory alopecia: alopecia areata, pseudopelade  
Erythematous target lesions: EM  
Nodular ulcerative lesions: nodular panniculitis  
Purpura, hemorrhage, punched-out lesions  
Ear margin necrosis, dependent edema: vasculitis, proliferative necrotizing otitis of kittens, cryoglobulinemia and cryofibrinogenemia, proliferative thrombovascular necrosis of the pinnae



## Immune-Mediated Disease

### Laboratory Diagnosis

#### Direct Coombs Test

Immune-mediated hemolytic anemia  
Hemolytic anemia in SLE

#### Antiplatelet Antibodies

Immune-mediated thrombocytopenia

#### Antineutrophil Antibodies

Immune-mediated neutropenia

#### Thyroxin and thyroglobulin autoantibodies

Hypothyroidism

#### Acetylcholine Receptor Autoantibodies

Myasthenia gravis

#### 2M Myofiber Autoantibodies

Masticatory muscle myositis

#### Antinuclear Antibody

SLE  
Chronic antigenic stimulation

#### Rheumatoid Factor

Rheumatoid arthritis (RA)

#### Direct Immunofluorescence

Antibody-complement deposition

### Differential Diagnosis for Immune-Mediated Arthritis

#### Erosive Immune-Mediated Arthritides

RA (dog, rarely in cat)  
Periosteal proliferative polyarthritis (cat, rarely in dog)

#### Nonerosive Immune-Mediated Arthritides

Idiopathic polyarthritis

- **Type I:** uncomplicated idiopathic arthritis (most common)
- **Type II:** idiopathic arthritis associated with infection remote from joints—respiratory tract, tonsils, conjunctiva (chlamydia in cats), urinary tract, uterus, skin, oral cavity
- **Type III:** idiopathic arthritis associated with gastroenteritis
- **Type IV:** idiopathic arthritis associated with malignant neoplasia—squamous cell carcinoma, heart base tumor, leiomyoma, mammary carcinoma, myeloproliferative disease (cats)

SLE

Drug-induced polyarthritis

- Sulfas, lincomycin, erythromycin, cephalosporins, penicillins, trimethoprim-sulfa (especially Doberman Pinscher)

Vaccination reaction

Polyarthritis/polymyositis syndrome

Polyarthritits/meningitis syndrome  
Familial renal amyloidosis in Chinese Shar-Peis  
Polyarthritits in adolescent Akitas  
Polyarthritits nodosa (inflammatory condition of small arteries—histopathologic diagnosis)

# Immune System Components

## Function

### Humoral immunity

#### B Lymphocytes and Plasma Cells

Production of immunoglobulins

### Cellular Immunity

#### T Lymphocytes

Production of lymphokines

Helper T cells

- Stimulate immune reactivity

Suppressor T cells

- Suppress immune reactivity

Antibody-dependent, cell-mediated cytotoxicity

Natural killer cells

- Direct cytotoxicity

### Phagocytic Cells

#### Mononuclear Phagocytic Cells

Antigen presentation

Phagocytosis of particles

#### Neutrophils and Eosinophils

Phagocytosis of particles

Antibody-dependent, cell-mediated cytotoxicity



# Mechanisms of Immunopathologic Injury

## Type I (immediate)

- Humoral immune system (T-helper cells and B cells), IgE, mast cells, inflammatory mediators)
- Skin, respiratory tract, GI tract commonly affected
- Examples include acute anaphylactic reaction, atopy, allergic bronchitis, feline asthma

## Type II (cytotoxic)

- Humoral immune system (IgG and IgM)
- Hematologic systems, neuromuscular junctions, and skin commonly affected
- Examples include immune-mediated hemolytic anemia, immune-mediated thrombocytopenia, myasthenia gravis, PF

## Type III (immune complex)

- Soluble immune complexes
- Kidney, joints, and skin commonly affected
- Examples include glomerulonephritis, SLE, RA

## Type IV (delayed type)

- Sensitized T lymphocytes, cytokines, neutrophils, and macrophages
- Endocrine glands, muscle commonly affected
- Examples include lymphocytic thyroiditis, myositis

# Organ Systems Affected by Autoimmune Disorders in the Dog and Cat

## Differential Diagnosis

### Hematologic

- Immune-mediated hemolytic anemia
- Pure red cell aplasia
- Immune-mediated thrombocytopenia
- Idiopathic neutropenia

### Joints (see Differential Diagnosis for Immune-Mediated Arthritis)

### Skin (see Autoimmune Skin Diseases)

### Eye

- Uveitis
- Retinitis

### Kidney

- Glomerulonephritis

### Respiratory Tract

- Allergic rhinitis
- Allergic bronchitis (asthma)
- Pulmonary infiltrates with eosinophils

### GI Tract

- Feline stomatitis, gingivitis
- Lymphocytic, plasmacytic enteritis
- Anal furunculosis (perianal fistula)

### Neurologic System

- Myasthenia gravis
- Myositis
- Polyradiculoneuritis
- Granulomatous meningoencephalitis
- Polyarteritis

### Endocrine Glands

- Thyroiditis (hypothyroidism)
- Adrenitis (hypoadrenocorticism)
- Insulitis (diabetes mellitus)

### Multisystemic Immune Disease

- SLE

# Systemic Lupus Erythematosus

## Organs and Tissues Affected

### RBCs

- Immune-mediated hemolytic anemia
- Pure red cell aplasia

### Platelets

- Immune-mediated thrombocytopenia

### Glomeruli

- Glomerulonephritis

### Synovium

- Nonerosive polyarthritis

### Blood vessels

- Vasculitis

### Epidermis

- Dermatitis

### Neutrophils

- Immune-mediated neutrophilia

### Clotting factors

- Coagulopathy

### Central nervous system

- Seizures, focal signs

### Skeletal muscle/nerve end plate

- Polymyositis
- Polyneuritis
- Myasthenia gravis

## Criteria for Diagnosis in Dogs and Cats

SLE is diagnosed when three or more of the following criteria are manifested simultaneously or at any time:

### Antinuclear antibodies (ANAs)

- Abnormal ANA titer in the absence of drugs or infectious or neoplastic conditions known to be associated with abnormal titers

### Cutaneous lesions

- Depigmentation, erythema, erosions, ulcerations, crusts, scaling, with biopsy findings consistent with SLE

### Oral ulcers

- Oral or nasopharyngeal ulceration, usually painless

### Arthritis

- Nonerosive, nonseptic arthritis involving two or more peripheral joints

### Renal disorders

- Glomerulonephritis or persistent proteinuria in the absence of UTI

### Anemia/thrombocytopenia

- Hemolytic anemia/thrombocytopenia in the absence of offending drugs

### Leukopenia

- Low total white cell count

### Polymyositis or myocarditis

- Inflammatory disease of skeletal or cardiac muscles

### Serositis

- Presence of a nonseptic inflammatory cavity effusion (abdominal, pleural, or pericardial)

### Neurologic disorders

- Seizures or psychosis in the absence of known disorders

### Antiphospholipids

- Prolongation of aPTT that fails to correct with a 1:1 mixture of patient's and normal plasma, in the absence of heparin or FDPs

---

## SECTION VII

# Infectious Disease

---

Anaplasmosis, Canine  
Bacterial Infections, Systemic  
Ehrlichiosis, Canine  
Influenza, Canine  
Influenza, Feline  
Mycoses, Systemic  
Neorickettsiosis, Canine  
Polysystemic Protozoal Diseases  
Rocky Mountain Spotted Fever  
Sepsis and Systemic Inflammatory Response Syndrome (SIRS)  
Vaccines, Recommended Core vs. Noncore  
Viruses, Canine  
Viruses, Feline

# **Anaplasmosis, Canine**

## **Clinical Signs**

Infection may be subclinical

Fever

Depression

Inappetence

Scleral injection

Lameness, stiffness, reluctance to move

Coughing (soft and nonproductive)

Lymphadenopathy

Splenomegaly

Neutrophilic polyarthritis (rare)

Central nervous system (CNS) signs?

Vomiting/diarrhea

May be more susceptible to other infections

## **Laboratory Abnormalities**

Thrombocytopenia

Lymphopenia

Eosinopenia

Mild regenerative anemia

Hypoalbuminemia

Mild to moderately elevated hepatic enzymes

## Bacterial Infections, Systemic

### Differential Diagnosis

#### Leptospirosis

Hepatic dysfunction, renal dysfunction, fever, anterior uveitis, icterus  
Coagulation abnormalities, vomiting/diarrhea, icterus, polyuria/polydipsia, anorexia  
Some cases may be subclinical

#### Borreliosis (Lyme Disease)

Fever, inappetence/lethargy, lymphadenopathy, polyarthritis  
Glomerulonephritis/acute, progressive renal failure, mild dermatologic lesions  
Meningitis/encephalitis (rare), myocarditis

#### Mycobacteriosis

Often asymptomatic, skin lesions, dermal nodules, draining tracts, lymphadenopathy,  
bronchopneumonia, pulmonary nodules, hilar lymphadenopathy, vomiting, diarrhea secondary  
to intestinal malabsorption, feline leprosy

#### Brucellosis (Dogs)

Clinical signs may be mild to absent  
Fever, lymphadenopathy  
Epididymitis, scrotal enlargement, scrotal dermatitis, infertility in males  
Abortion, early embryonic death, fetal resorption, in pregnant bitches  
Diskospondylitis  
Rarely uveitis, glomerulonephritis, meningoencephalitis

#### Tetanus

Localized tetanus, especially cats; stiffness in a muscle of limb  
Generalized tetanus stiff gait, outstretched or dorsally curved tails, extreme muscle rigidity,  
hypersensitivity to touch, light, and sounds  
Ears erect, lips drawn back (sardonic grin), protrusion of globe, enophthalmos  
Trismus (lockjaw), laryngeal spasm, regurgitation, megaesophagus leading to aspiration  
pneumonia, seizures

#### Botulism

Generalized lower motor neuron and parasympathetic dysfunction, CN signs, mentation is normal  
Quadriplegia, megaesophagus, respiratory paralysis; may lead to death

#### Feline Plague (*Yersinia pestis*)

Spread by fleas  
May show signs of bubonic, septicemic, and pneumonic plague  
Depression  
Cervical swellings, draining tracts  
Dyspnea or cough

#### Mycoplasmosis/Ureaplasmosis (Cats)

Conjunctivitis, sneezing, mucopurulent nasal discharge, coughing, dyspnea, fever, lameness,  
swollen joints, subcutaneous abscessation

### Members of the Order Rickettsiales of Clinical Importance in Dogs and Cats

#### Rickettsioses (Spotted Fever Group Rickettsiae)

*Rickettsia rickettsia*

Species of the following tick genera transmit spotted fever group agents: *Dermacentor*, *Rhipicephalus*, *Haemaphysalis*, and *Amblyomma*

### **Ehrlichiosis (Canine)**

*Ehrlichia canis*, *E. chaffeensis*, *E. ewingii*, *E. muris*, and *E. ruminantium*

### **Anaplasmosis (Canine and Feline)**

*Anaplasma phagocytophilum*

*Anaplasma platys* (canine cyclic thrombocytopenia: mildly pathogenic)

### **Neorickettsiosis**

*Neorickettsia helminthoeca*, *N. risticii*

### **Bartonellosis, Canine**

#### **Clinical Findings**

- Many species of *Bartonella* are suspected to cause disease in dogs (e.g., *B. vinsonii*, *B. henselae*, *B. clarridgeiae*, *B. elizabethae*)
- Fever
- Endocarditis, myocarditis, arrhythmias
- Epistaxis
- Intermittent lameness
- Bone pain
- Granulomatous lymphadenitis
- Dermatologic lesions/cutaneous vasculitis
- Anterior uveitis
- Polyarthritis
- Meningoencephalitis
- Immune-mediated hemolytic anemia
- Thrombocytopenia
- Eosinophilia
- Peliosis hepatitis
- Granulomatous hepatitis
- Chronic weight loss

### **Bartonellosis, Feline**

#### **Subclinical Disease in Most Cats**

Uveitis?

Endocarditis?

#### **Anaplasmosis**

*Anaplasma phagocytophilum*, formally known as *Ehrlichia equi*, *E. phagocytophila*

#### **Cause of Canine Granulocytic Ehrlichiosis**

Clinical signs:

Fever

Depression

Inappetence

Scleral injection

Lameness/polyarthritis

Hemorrhage, epistaxis, melena, petechiae

Coughing

Lymphadenopathy

Splenomegaly



Vomiting/diarrhea  
Lymphopenia, eosinopenia, mild nonregenerative anemia  
Hypoalbuminemia, elevated hepatic enzymes  
Proprioceptive deficits or other signs of meningitis

## **Anaplasma platys**

### **Cause of Canine Thrombocytic Anaplasmosis**

#### **Forms of Morula that Can Be Visualized in Platelets**

Clinical signs:

Majority of cases in United States have been mild or subclinical

More severe signs in European or South American cases include:

- Fever
- Splenomegaly
- Hemorrhage

# Ehrlichiosis, Canine

## Clinical Findings

### Acute

Fever  
Anorexia/weight loss  
Depression  
Serous or purulent oculonasal discharge  
Lymphadenopathy/splenomegaly  
Peripheral edema  
Petechial and ecchymotic hemorrhages  
Neurologic signs (ataxia, seizures, vestibular signs, hyperesthesia, CN defects)  
Dyspnea  
History of recent or present tick bite  
Thrombocytopenia  
Leukopenia followed by leukocytosis and monocytosis  
Low-grade nonregenerative anemia, unless hemorrhage  
Variable *Ehrlichia* titer, PCR positive

### Subclinical

No clinical abnormalities apparent  
Hyperglobulinemia, thrombocytopenia, neutropenia, lymphocytosis, monocytosis  
Positive *Ehrlichia* titer, PCR positive

### Chronic

Depression  
Pale mucous membranes  
Weight loss  
Abdominal pain  
Splenomegaly  
Epistaxis, retinal hemorrhage, petechia and ecchymoses, melena, hematochezia, hematuria, and other examples of hemorrhage  
Lymphadenopathy  
Stiffness, swollen/painful joints, polymyositis  
Hepatomegaly  
Dyspnea, interstitial or alveolar lung infiltrates  
Perivascular retinitis, hyphema, retinal detachment, anterior uveitis, corneal edema  
Seizures, paresis, meningeal pain, CN deficits  
Arrhythmias  
Polyuria/polydipsia  
Secondary opportunistic infection (viral papillomatosis, protozoal infections, bacteriuria)  
Monocytosis, lymphocytosis, thrombocytopenia, nonregenerative anemia, hyperglobulinemia, hypoalbuminemia, hypocellular bone marrow, proteinuria, polyclonal or monoclonal gammopathy, nonseptic suppurative polyarthritis, cerebrospinal fluid (CSF) mononuclear pleocytosis  
Increased ALT and ALP  
Positive *Ehrlichia* titer, PCR positive

## Influenza, Canine

### Clinical Features

- **H3N8 strain**—originated in Florida, thought to have mutated from equine flu strain; most outbreaks in group housed dogs (race tracks, animal shelters)
- **H3N2 strain**—outbreak in 2015 started in Chicago. Thought to have resulted from direct transfer of avian influenza virus in markets in Asia (Korea, Thailand, China)
- Individual pets often had a recent history of exposure to other dogs
- Mild form may cause a harsh cough similar to cough heard with infectious tracheobronchitis
- More commonly cough is soft and moist, cough may persist for as long as a month
- Fever (may reach 104-106°F with severe form)
- Mucopurulent nasal discharge
- Increased respiratory rate progressing to respiratory distress
- May progress to overt pneumonia (severe form)
- Mortality rate less than 5%. Very young and very old are most at risk.

## Influenza, Feline

- Transition of H3N2 causing mild disease in cats has been documented.
- In late 2016, over 40 cats tested positive for a low pathogenic avian influenza virus A, H7N2 in a shelter in Manhattan, New York.

# Mycoses, Systemic

## Clinical Findings

### Blastomycosis

Restricted primarily to Mississippi, Ohio, Missouri, Tennessee, and St. Lawrence River valleys plus the southern Great Lakes and the southern Mid-Atlantic states. Recent reports of cases in northern California and Pacific Northwest. Also seen in Canada (Alberta, Manitoba, Ontario, Quebec), Central America, and Africa.

Sporting breeds predisposed because of greater exposure, males more than females

Anorexia, depression, weight loss, cachexia, fever, mild-to-severe dyspnea, cyanosis, cough, chylothorax, diffuse lymphadenopathy, papules, plaques and ulcerative nodules, paronychia, chorioretinitis, conjunctivitis, keratitis, iridocyclitis, anterior uveitis, subretinal granulomas, retinal detachment, secondary glaucoma, lameness from osteomyelitis, splenomegaly

Radiographically, infiltrative bronchointerstitial and alveolar disease, hilar lymphadenopathy

### Histoplasmosis

Restricted primarily to Mississippi, Missouri, and Ohio River valleys and Mid-Atlantic states

Sporting breeds predisposed because of greater exposure

Common clinical signs include anorexia, fever, depression, weight loss, cough, dyspnea, diarrhea (large bowel diarrhea most often, may see protein-losing enteropathy), hepatosplenomegaly, icterus, ascites, and lymphadenopathy.

Less common signs include lameness secondary to osteomyelitis or polyarthritis, chorioretinitis, CNS disease, and cutaneous lesions.

## Differential Diagnosis for GI Signs Seen in Dogs and Cats with Histoplasmosis

### Large Intestinal Disease

#### Diet-Associated Colitis

- Dietary hypersensitivity
- Foreign material-induced colitis

#### Idiopathic Colitis

- Lymphocytic-plasmacytic colitis
- Eosinophilic colitis
- Granulomatous colitis
- Histiocytic ulcerative colitis of Boxer dogs
- Suppurative colitis

#### Parasitic and Protozoal Colitis

- Trichuriasis (whipworm)
- Ancylostomiasis (hookworm)
- Entamebiasis
- Balantidiasis
- Giardiasis

#### Bacterial colitis

- Salmonellosis
- *Campylobacter jejuni*
- *Yersinia enterocolitica*, *Y. pseudotuberculosis*
- Mycobacteria
- *Clostridium perfringens*, *C. difficile*

#### Fungal colitis

- Candidiasis
- GI pythiosis
- Protothecosis

Cecocolic or ileocolic intussusception

Pancreatitis-associated colitis

### Small Intestinal Disease

Idiopathic inflammatory bowel disease

- Lymphocytic-plasmacytic enteritis
- Eosinophilic enteritis
- Granulomatous enteritis

Intestinal lymphosarcoma

Parasitic enteritis

- Ancylostomiasis
- Toxocariasis
- Chronic giardiasis

Infectious enteritis

- Small intestinal bacterial overgrowth
- GI pythiosis

Lymphangiectasia

Exocrine pancreatic insufficiency

Partial intestinal obstruction

Chronic enteropathy of Shar-Peis

Immunoproliferative enteritis of Basenjis

### Coccidioidomycosis

Primarily southwestern United States, California, Mexico, Central and South America

Common clinical signs include lameness with swollen and painful joints and bones, cough, dyspnea, anorexia, weakness, pleural effusion, and cutaneous lesions over infected bones.

Less common signs include myocarditis, icterus, renomegaly, splenomegaly, hepatomegaly, orchitis, epididymitis, keratitis, iritis, granulomatous uveitis, glaucoma, seizures, ataxia, and central vestibular disease.

### Cryptococcosis

Found worldwide, more common in southern United States, most common in cats

Common clinical signs include upper respiratory signs, unilateral-to-bilateral nasal discharge, soft masses in nasal cavity or over bridge of nose, ulcerative skin lesions, lymphadenopathy, granulomatous chorioretinitis, and retinal detachment.

Less common signs include fever, lung involvement, CNS involvement caused by invasion through cribriform plate, depression, seizures, circling, ataxia, blindness, head pressing, and paresis.

### Aspergillosis

Dogs affected more often than cats

Nasal turbinate destruction, frontal sinus osteomyelitis, mucoid to hemorrhagic nasal discharge, epistaxis

May lead to masticatory muscle atrophy and CNS disease by erosion through cribriform plate

In rare cases, disseminates and causes multiple organ disease

### Pythiosis, Lagenidiosis (*Pythium insidiosum*, *Lagenidium giganteum*)

Severe, often fatal, chronic GI and cutaneous diseases

### Zygomycosis (Multiple Fungi in Class Zygomycetes)

Nasopharyngeal involvement, poorly responsive to therapy

## Differential Diagnosis for Systemic Manifestations

Multisystemic granulomatous, neoplastic, and immune-mediated diseases must be differentiated from disseminated systemic mycoses.

### Differential Diagnosis for Nodular Skin Disease

#### Bacteria Skin Disease

- Actinomycosis
- Mycobacteriosis
- Botryomycosis
- Brucellosis
- *Rhodococcus equi* infection
- *Bartonella vinsonii* subsp. *Berkhoffi* infection

### **Mycotic and Miscellaneous Infectious Skin Disease**

- Cryptococcosis
- Blastomycosis
- Coccidioidomycosis
- Sporotrichosis
- Basidiobolomycosis
- Conidiobolomycosis
- Phaeohyphomycosis
- Hyalohyphomycosis
- Eumycotic mycetoma
- Dermatophytic mycetoma
- Protothecosis
- Pythiosis
- Lagenidiosis
- Nodular leishmaniasis

### **Noninfectious Pyogranulomatous Skin Disease**

- Foreign body reaction
- Idiopathic nodular panniculitis
- Sebaceous adenitis (nodular form)
- Canine cutaneous sterile pyogranulomatous/granuloma syndrome

### **Neoplasia**

- Squamous cell carcinoma
- Cutaneous lymphoma
- Mycosis fungoides (cutaneous T-cell lymphoma)
- Cutaneous histiocytosis

### **Miscellaneous Diseases**

- SLE
- Systemic vasculitis
- Cutaneous embolic disease

## **Differential Diagnosis for Chorioretinitis, Exudative Retinal Detachment, and Panophthalmitis**

### **Fungal**

- Blastomycosis
- Cryptococcosis
- Coccidioidomycosis
- Geotrichosis
- Histoplasmosis
- Aspergillosis

### **Neoplasia**

- Lymphosarcoma
- Metastatic neoplasia

### Miscellaneous Infectious Causes

- Protothecosis
- Brucellosis
- Toxoplasmosis
- *Neospora caninum* infection
- Leishmaniasis

Lymphadenopathy must be differentiated from numerous causes, including lymphosarcoma, other fungal infections, rickettsial diseases, brucellosis, mycobacteriosis, protothecosis, and leishmaniasis.

Solitary bone lesions must be differentiated from primary or metastatic neoplasia and other fungal or bacterial osteomyelitis.



## Neorickettsioses, Canine

*Neorickettsia helminthoeca* (salmon poisoning disease)

Restricted to western slopes of Cascade Mountains from northern California to southern Vancouver Island

Vector is a fluke—*Nanophyetus salmincola*. Dogs become infected from ingesting parasitized fish.

### Clinical Signs

Fever

Anorexia/weight loss

Depression

Lymphadenopathy

Vomiting

Diarrhea

Hematochezia

Neutrophilia with left shift, lymphopenia, monocytosis, thrombocytopenia

Electrolyte derangements, elevated hepatic enzymes, hypoalbuminemia

### *Neorickettsia risticii*

Cause of equine Potomac horse fever

Vector is suspected to be a fluke—*Acanthatrium oregonense*

Has been identified by culture and PCR in dogs with the following signs:

### Clinical Signs

Lethargy

Intermittent vomiting

Bleeding tendencies

Polyarthritis

Neurologic signs

Dependent edema

Anemia

Thrombocytopenia

# Polysystemic Protozoal Diseases

## Clinical Findings

### Feline Toxoplasmosis

Acute toxoplasmosis: may induce a self-limiting, small-bowel diarrhea

Disseminated toxoplasmosis: overwhelming intracellular replication of tachyzoites after primary infection—depression, anorexia, fever, hypothermia, peritoneal effusion, icterus, dyspnea, death—coinfection with FeLV, FIV, FIP, and others may predispose to disseminated toxoplasmosis

Chronic toxoplasmosis: anterior or posterior uveitis, fever, muscle hyperesthesia, weight loss, anorexia, seizures, ataxia, icterus, diarrhea, pancreatitis

### Canine Toxoplasmosis

Respiratory, GI, neuromuscular signs: fever, vomiting, diarrhea, dyspnea, icterus, ataxia, seizures, tremors, CN deficits, paresis, paralysis, myositis, lower motor neuron disease, myocardial disease, chorioretinitis, anterior uveitis, iridocyclitis, optic neuritis (ocular lesions less common in dogs than cats)

### Neosporosis

Most common in neonates but can be seen at any age

Ascending paralysis, hyperextension of hind limbs, muscle atrophy, polymyositis, multifocal CNS disease, myocarditis, dysphagia, ulcerative dermatitis, pneumonia, hepatitis

### Babesiosis

Anemia, fever, pale mucous membranes, tachycardia, tachypnea, depression, anorexia, weakness, icterus, petechiae, hepatosplenomegaly, DIC, metabolic acidosis, renal disease

### Cytauxzoonosis

Fever, anorexia, dyspnea (pneumonitis), depression, icterus, pale mucous membranes, death

### Hepatozoonosis (*Hepatozoon canis* and *H. americanum*)

Most common in puppies and immunosuppressed dogs, but *H. americanum* can be primary  
Fever, weight loss, severe hyperesthesia, anorexia, anemia, depression, oculonasal discharge, bloody diarrhea

### Leishmaniasis

Weight loss, normal to increased appetite, polyuria/polydipsia, muscle wasting, depression, vomiting, diarrhea, cough, epistaxis, sneezing, melena, splenomegaly, facial alopecia, rhinitis, dermatitis, icterus, swollen and painful joints, uveitis, conjunctivitis

Dermatologic lesions include hyperkeratosis, scaling, mucocutaneous ulcers, and intradermal nodules on muzzle, ears, and footpads.

### American Trypanosomiasis (*Trypanosoma cruzi*)

Acute infection: myocarditis, heart failure—lymphadenopathy, pale mucous membranes, tachycardia, pulse deficits, hepatomegaly, abdominal distension, anorexia, diarrhea, neurologic signs

Chronic infection: Those that survive acute infection may present with chronic dilative cardiomyopathy—right-sided heart failure, conductive disturbances, supraventricular arrhythmias.



# Rocky Mountain Spotted Fever

## Clinical Findings

Depression/lethargy  
Fever  
Anorexia  
Myalgia/arthralgia  
Lymphadenopathy  
Vestibular deficits  
Conjunctivitis/scleral congestion/hyphema/iridal and retinal hemorrhage  
Pneumonitis/dyspnea/cough  
Abdominal pain  
Edema of face and extremities  
Epistaxis  
Melena  
Hematuria  
Anterior uveitis  
Rash/petechiae  
Nausea/vomiting  
Diarrhea  
Vasculitis/thrombocytopenia/DIC  
Hyperesthesia/spinal cord signs  
Seizures  
Cardiac arrhythmias  
Icterus  
Acute renal failure  
Coma/stupor  
Polyuria/polydipsia

# Sepsis and Systemic Inflammatory Response Syndrome (SIRS)

## Definitions

*Bacteremia*: the presence of viable bacteria in the bloodstream

*Sepsis*: infection-induced systemic inflammation

*Severe sepsis*: organ dysfunction and manifestations of hypoperfusion or hypotension secondary to sepsis

*Septic shock*: hypotension secondary to sepsis, not responsive to intravenous (IV) fluid therapy

*SIRS*: systemic inflammation caused by either infectious or noninfectious processes. Diagnosis of SIRS is based on fulfillment of at least two of four criteria (tachycardia, tachypnea, hypothermia, or hyperthermia and either leucocytosis, leucopenia, or bands).

*Multiple organ dysfunction syndrome (MODS)*: altered function of two or more organs secondary to SIRS such that homeostasis cannot be maintained without intervention

*Acute respiratory distress syndrome*: a pulmonary inflammatory disorder characterized by noncardiogenic pulmonary edema, neutrophilic inflammation, and hypoxemia

## Noninfectious Causes of SIRS

Pancreatitis  
Tissue trauma  
Heat stroke  
Ischemia  
Burns  
Pansystemic neoplasia

## Infectious Causes of SIRS (Sepsis)

Peritonitis  
Pyometra  
Prostatitis  
Prostatic abscess  
Pyelonephritis  
Pneumonia  
Pyothorax  
Gastroenteritis  
Endocarditis  
Nosocomial infections (IV catheters, urinary catheters, etc.)

## Clinical Findings of Sepsis and SIRS

Fever or hypothermia  
Tachycardia, tachypnea  
Neutrophilia with left shift or leukopenia  
Anemia  
Depression  
Bounding or diminished pulses  
Brick-red mucus membranes or pallor  
Hypothermia  
Thrombocytopenia  
Hypoalbuminemia, hypoglycemia  
DIC  
Bilirubinemia  
Elevated hepatic enzymes  
Azotemia

Oliguria  
Lactic acidosis  
Hypoxemia  
Signs related to underlying condition

## Vaccines, Recommended Core vs. Noncore

### Core Vaccines for Dogs

- Distemper
- Parvovirus
- Adenovirus-2
- Rabies

### Core Vaccines for Cats

- Parvovirus (panleukopenia)
- Herpesvirus-1
- Calicivirus
- Rabies

### Noncore Vaccines for Dogs

Need determined by individual clinician after assessment of patient risk

- Bordetellosis
- Parainfluenza
- Canine influenza
- Leptospirosis
- Lyme borreliosis
- *Crotalus atrox*
- *Porphyromonas* spp.
- Canine influenza (strains H3N2 and H3N8)

### Noncore Vaccines for Cats

Need determined by individual clinician after assessment of patient risk

- FeLV
- FIV
- *Chlamydomphila felis* (formally, *Chlamydia psittaci*)
- Bordetellosis

## Viruses, Canine

### Common Viral Agents of Diseases of Dogs

#### Parvovirus

May be asymptomatic or fulminant disease  
Anorexia, lethargy, fever, vomiting, hemorrhagic diarrhea, myocarditis (rare)  
Worse in very young and parasitized puppies  
Neutropenia, hypoalbuminemia, severe dehydration, secondary septicemia

#### Coronavirus

Diarrhea (infrequently blood in feces), vomiting, anorexia, lethargy, often self-limiting  
Canine respiratory coronavirus, part of “kennel cough” complex  
Coughing, sneezing, nasal discharge  
Canine pancytotropic coronavirus  
Severe clinical disease in puppies and juvenile dogs  
Fever, lethargy, anorexia, vomiting, hemorrhagic diarrhea, ataxia, seizures

#### Rotavirus

Vomiting, diarrhea (rarely bloody), anorexia, typically recover after 5-7 days

#### Adenovirus Type 1 (Infectious Canine Hepatitis)

Fever, anorexia, lethargy, depression, abdominal pain, pale mucous membranes, tonsillitis, pharyngitis, coughing, hepatomegaly  
Severe cases: coagulation abnormalities, petechiae, ecchymosis, DIC, rarely icterus, hepatic encephalopathy  
Anterior uveitis and glomerulonephritis secondary to immune complex deposition

#### Canine Distemper Virus

See the next list.

#### Canine Influenza A Subtype H3N8 Virus, Subtype H3N2

Acute onset of coughing, sneezing, nasal discharge, ocular discharge  
Low-grade fever  
Secondary commensal bacterial infections leading to mucopurulent discharge and productive cough  
May lead to pneumonia with high fever, inappetence, productive cough, and increased respiratory effort

#### Rabies Virus

Variable incubation period, prodromal phase: nervousness, anxiety, paresthesia  
Progress to forebrain signs (“furious” form of rabies): irritability, restlessness, pica, photophobia, increased saliva production with decreasing ability to swallow, hyperesthesia progressing to incoordination, seizures, and death  
May also progress to “dumb” form: paralysis, lower motor disease, leading to coma, respiratory paralysis, and death

#### Pseudorabies

Suspected to be result from ingestion of infected raw pork  
Neurologic dysfunction: ataxia, abnormal papillary light response, restlessness, trismus, cervical rigidity, ptialism, tachypnea, excoriation from pruritus of head and neck; vomiting, diarrhea; most dogs die within 48 hours

#### Parainfluenza and Adenovirus Type 2



Hacking cough with gagging, easily elicited with tracheal palpation; cough may be paroxysmal, usually subsides within 7-10 days, and may lead to secondary bacterial or mycoplasmal infection

### **Canine Herpesvirus**

Abortion, stillbirths; puppies born live progress to crying, hypothermia, soft stools, petechiae, cessation of nursing, and death

Older puppies develop mild respiratory signs that may emerge later as neurologic disease (ataxia, blindness, central vestibular disease).

Adult dogs: usually asymptomatic, rhinitis, pharyngitis, vaginal or preputial hyperemia, hyperplasia of vaginal mucosal lymphoid follicles, submucosal hemorrhage

### **Canine Oral Papillomavirus**

Oral papilloma (warts), may be quite extensive, spontaneously regress

### **West Nile Virus**

Clinical disease is uncommon.

### **Bornavirus**

Seropositivity in the absence of clinical signs appears possible.

Tremors, salivation, mydriasis, circling

## **Canine Distemper Virus Infection, Clinical Findings**

### **General Signs**

Fever

Lethargy

Depression

Anorexia

Dehydration

### **Respiratory Tract**

Mucoid-to-mucopurulent discharge

Bronchopneumonia

- Coughing
- Crackles on auscultation
- Increased bronchovesicular sounds
- Dyspnea

Sneezing

### **GI Tract**

Vomiting

Small-bowel diarrhea

### **Ocular Disease**

Mucopurulent ocular discharge

Chorioretinitis, medallion lesions, optic neuritis, retinal detachment

Keratoconjunctivitis sicca

Anterior uveitis

### **Neurologic Disease**

Spinal cord lesion: paresis and ataxia

Central vestibular disease: head tilt, nystagmus, other CN and conscious proprioception deficits

Cerebellar disease: ataxia, head bobbing, hypermetria

Cerebral disease: seizures, blindness

Chorea myoclonus: rhythmic jerking of single muscles or muscle groups

### **Miscellaneous**

Tonsillar enlargement  
Pustular dermatosis  
Hyperkeratosis of nose and footpads  
Enamel hypoplasia

### **In Utero Infection**

Stillbirth  
Abortion  
“Fading puppy” syndrome in neonatal period  
CNS signs at birth

## Viruses, Feline

### American Association of Feline Practitioners Guidelines for Retroviral Testing in Cats

- Sick cats should be tested even if they have tested negative before.
- Cats and kittens should be tested when they are first acquired.
- Even cats not expected to live with other cats should be tested. This provides a health assessment of the individual; other cats may join the household; indoor cats may escape and expose other cats.
- Tests should be performed at adoption, and negative cats should be retested a minimum of 60 days later.
- Cats with known recent exposure to a retrovirus-infected cat or a cat with unknown status, particularly via a bite wound, should be tested regardless of previous test results. Testing should be done immediately and, if negative, should be repeated after a minimum of 60 days (when the type of potential viral exposure is unknown, retesting for both viruses after 60 days is most practical).
- Cats living in households with other cats infected with FIV or FeLV should be tested annually.
- High-risk cats (cats in cat-dense neighborhoods or cats that fight and get cat-bite wounds and abscesses) should be tested regularly.
- Cats should be tested before initial vaccination against FeLV or FIV.
- Always confirm an initial positive retrovirus test.
- Cats used for blood or tissue donation should have negative screening tests for FeLV and FIV and should be negative for real-time PCR tests.
- Intermittent retesting is not necessary for cats with confirmed negative infection status unless there is opportunity for exposure to infected cats or if they become ill.
- Each cat should be individually tested. Testing of one cat as a proxy for another or pooling samples from multiple cats for testing is inappropriate.

### Clinical Signs of Rabies Virus Infection in Cats

- Initially signs are nonspecific: lethargy, inappetence, vomiting, diarrhea
- Rapid and continual deterioration of clinical conditions, no waxing and waning
- Behavioral changes: more reclusive or attention seeking, may unpredictably attack animate, inanimate, or unseen objects
- Irrevocable progression to classic signs, ptyalism with decreased ability to swallow leads to contamination of oral cavity, chin, and forelegs with potentially infectious saliva. CN signs such as anisocoria, pupil dysfunction, facial or tongue paresis, and changes in phonation may occur.
- Auditory, visual, or tactile stimulation may elicit profound aggression to self-mutilation.
- Become profoundly moribund to comatose to death; 100% fatal

### Feline Infectious Peritonitis (FIP, Feline Coronavirus Infection), Clinical Findings

#### Signalment and History

Purebred cats from cattery

Multicat households

Younger than 5 years or older than 10 years of age

Previous history of mild, self-limiting GI or respiratory disease

Anorexia, weight loss, depression

Seizures, nystagmus, ataxia

Acute, fulminant course in cats with effusive FIP

Chronic, intermittent course in cats with noneffusive FIP

The acute and chronic courses are different stages of the same disease, not separate forms, and both carry a poor prognosis.

## Physical Examination Findings

Fever  
Weight loss  
Abdominal distension/fluid wave  
Abdominal mass (focal intestinal granuloma, lymphadenopathy)  
Icterus  
Muffled heart or lung sounds  
Dyspnea secondary to pleural effusion  
Hepatomegaly  
Chorioretinitis, iridocyclitis  
Splenomegaly  
Pale mucous membranes with or without petechiae  
Multifocal neurologic abnormalities  
Irregularly marginated kidneys  
Renomegaly  
Ataxia, personality change, nystagmus, seizures

## Clinicopathologic Abnormalities

CBC: nonregenerative anemia, neutrophilia with or without left shift, lymphopenia  
Serum chemistry: elevated ALP and ALT, hyperbilirubinemia, hyperglobulinemia (polyclonal, rarely monoclonal gammopathy), azotemia (prerenal or renal)  
Urinalysis: proteinuria  
Nonseptic, pyogranulomatous exudate in peritoneal cavity, pleural space, and pericardium  
Positive coronavirus antibody titer (especially in noneffusive cases)  
CSF tap: increased protein concentration, neutrophilic pleocytosis, coronavirus antibodies  
May see hydrocephalus with CT or magnetic resonance imaging (MRI) of the brain in cats with CNS FIP  
Histopathology: pyogranulomatous inflammation in perivascular locations of tissues  
Positive for coronavirus on immunofluorescence or reverse-transcriptase polymerase chain reaction (RT-PCR) testing of abdominal or pleural effusions (although these tests do not differentiate between FIP-causing viruses and “harmless” feline enteric coronavirus)

## FIV Infection, Clinical Findings

### Primary Phase of Infection

Low-grade fever  
Lymphadenopathy  
Neutropenia  
Often is unnoticed

### Latent Phase

No clinical signs for months to years

### Immunodeficiency Phase

#### Primary Viral Effects

Weight loss  
Nonregenerative anemia, neutropenia, thrombocytopenia  
Small-bowel diarrhea  
Glomerulonephritis  
Myeloproliferative disorders  
Lymphoma  
Renal failure  
Anterior uveitis, pars planitis  
Behavioral abnormalities

## Opportunistic Infectious Agents

Cutaneous: atypical mycobacteriosis, demodicosis, *Notoedres* and *Otodectes* infestation, dermatophytosis, cryptococcosis, cowpox

GI: cryptosporidiosis, coccidiosis, giardiasis, salmonellosis, campylobacteriosis, others

Renal: bacterial infections, FIP, FeLV

Urinary tract: bacterial infections

Neoplasia: FeLV

Hematologic: *Mycoplasma haemofelis*, FeLV, bartonellosis

Neurologic: toxoplasmosis, cryptococcosis, FIP, FeLV

Ophthalmologic: toxoplasmosis, FIP, cryptococcosis, herpesvirus, bartonellosis

Pneumonia/pneumonitis: bacterial, toxoplasmosis, cryptococcosis

Pyothorax: bacterial

Stomatitis: calicivirus, bacterial, candidiasis, bartonellosis

Upper respiratory: herpesvirus, calicivirus, bacterial, cryptococcosis

## FeLV, Clinical Findings

### Acute Phase

Fever

Malaise

Diarrhea

Leukopenia

### General Signs

Anorexia

Weight loss

Depression

Many FeLV-positive cats are asymptomatic at diagnosis

### Neoplastic

Lymphoma: mediastinal, multicentric, alimentary, renal

Leukemia: lymphocytic, myelogenous, erythroid, megakaryocytic

Myeloproliferative disorders

Fibrosarcoma

### Icterus

Prehepatic: immune-mediated RBC destruction induced by FeLV or secondary infection with *Mycoplasma haemofelis*

Hepatic: hepatic lymphoma, focal liver necrosis, hepatic lipidosis

Posthepatic: alimentary lymphoma

### Bone marrow

Pure red cell aplasia

Regenerative anemia (less common and often associated with coinfection with *Mycoplasma haemofelis*)

Myeloproliferative disease (anemia, leukopenia, thrombocytopenia)

### Stomatitis

Bacterial infection

Calicivirus infection

### Rhinitis/pneumonia

Bacteria

Herpesvirus and calicivirus

## Renal

Glomerulonephritis

Renal failure

Urinary incontinence: sphincter incompetence or detrusor hyperactivity

## Ocular Lymphoma

Aqueous flare, mass lesions, keratic precipitates, lens luxations, glaucoma, anterior uveitis

## Neurologic Polyneuropathy or Lymphoma

Anisocoria, ataxia, weakness, tetraparesis, paraparesis, behavioral changes, urinary incontinence

Secondary infection with FIP, *Toxoplasma gondii*, *Cryptococcus neoformans*

## In Utero Infection

Abortion, stillbirth, infertility, kitten mortality complex ("fading kitten" syndrome)

## Lameness

Neutrophilic polyarthritis secondary to immune complex deposition

Multiple cartilaginous exostoses

## FeLV, Possible Outcomes After Exposure

### Progressive Infection

Viral replication in lymphoid tissue and bone marrow, spread to mucosal and glandular tissues, leading to shedding of virus. Most cats become persistently infected and frequently die of an FeLV-associated disease within a few years.

### Regressive Infection

Effective immune response limits viral replication. FeLV antigen detectable in peripheral blood within 2-3 weeks after exposure but disappears 2-8 weeks later. May not ever develop antigenemia. Clinical relevance of regressive infection is not clear. May have persistent integration of FeLV DNA in their genome but are unlikely to develop FeLV-associated diseases. Do not shed virus.

### Abortive Exposure

Seen infrequently after experimental FeLV inoculation characterized by negative results for culturable virus, antigen, viral RNA, and proviral DNA

### Focal Infections

Rare events in which cats have FeLV infection restricted to certain tissues such as spleen, lymph nodes, small intestine, or mammary glands

## Other Feline Viral Diseases

### Upper Respiratory Tract Viruses

Herpesvirus type 1: ocular and nasal disease

Calicivirus: ocular, nasal, and oral disease; rarely joint disease

Reovirus: conjunctivitis, respiratory lesions, diarrhea experimentally, no evidence of importance in the field

### Enteric Viruses

Feline parvovirus (panleukopenia virus): enteritis, panleukopenia, cerebellar hypoplasia, fetal death

Feline coronavirus: mild enteritis, FIP

Rotavirus: rare cause of mild diarrhea

Astrovirus: uncommon cause of persistent watery diarrhea

Torovirus: may be associated with protruding nictitating membrane and diarrhea syndrome

### **Miscellaneous**

Cowpox virus: mainly see skin lesions; sporadic disease in cats

Hantavirus: zoonotic disease of wild rodents; clinical significance in cats not known

Rabies virus

Pseudorabies virus: cats are a rare host, severe behavioral changes, pruritus, paralysis, coma, death

Feline herpesvirus type 2: possible association with feline idiopathic lower urinary tract disease

---

## **SECTION VIII**

# Joint and Bone Disorders

---

Arthritis  
Bone Disorders



## Arthritis

### Differential Diagnosis: Infectious Arthritis

#### Septic Arthritis

##### Bacterial Suppurative Arthritis

Penetrating wounds

- Animal bites
- Iatrogenic
- Infection during surgery, arthrocentesis

Trauma (e.g., hit by car)

Hematogenous

- Endocarditis
- Omphalophlebitis
- Pyoderma
- Other foci of infection

#### Lyme Arthritis

*Borrelia burgdorferi*

Transmitted by *Ixodes* ticks

#### Bacterial I-Form Arthritis

Cell wall-deficient bacteria

Causes suppurative arthritis and subcutaneous abscesses in cats

#### *Mycoplasma* Arthritis

Debilitated and immunosuppressed animals

*M. gatae*, *M. felis* in cats

#### Fungal Arthritis (Rare)

*Coccidioides immitis*

*Blastomyces dermatitidis*

*Cryptococcus neoformans*

*Sporothrix schenckii*

*Aspergillus terreus*

#### Rickettsial Arthritis

Rocky Mountain spotted fever (*Rickettsia rickettsii*)

*Ehrlichia canis*

*Anaplasma phagocytophilum*

#### Protozoal Arthritis

Leishmaniasis (*Leishmania* spp.)

Toxoplasmosis (rare)

Neosporosis (*Neospora caninum*): polyarthritis, polymyositis, neurologic disease

Hepatozoonosis: polyarthritis and polymyositis in dog and cat

Babesiosis (rare, more often causes severe anemia)

Chlamydiae (feline)

#### Viral Arthritis

Calicivirus infection in cats

### Differential Diagnosis of Noninfectious Arthritis

## **Nonerosive**

Immune-mediated polyarthritis

SLE

Reactive polyarthritis (bacterial, fungal, parasitic, neoplastic, enterohepatic, drug reaction, vaccine induced)

Breed-associated syndromes

Polyarthritis (Akita, Newfoundland, Weimaraner)

Polyarthritis/meningitis (Akita, Beagle, Bernese Mountain Dog, Boxer, German Shorthaired Pointer)

Polyarthritis/polymyositis (spaniels)

Familial Shar-Pei fever

Lymphoplasmacytic synovitis

Osteoarthritis (secondary to trauma, joint instability, incongruity, immobilization, or osteochondrosis)

## **Erosive**

Rheumatoid-like arthritis

Erosive polyarthritis of Greyhounds

Feline chronic progressive polyarthritis

## Bone Disorders

### Differential Diagnosis: Congenital, Developmental, Genetic

#### Congenital

Hemimelia, phocomelia, amelia: absence of portions or entire limb (amelia)

Syndactyly: fusion of two or more digits; rarely clinically significant

Polydactyly: extra digits

Ectrodactyly: third metacarpal and digit missing forming a cleft (split or “lobster” claw)

Segmented hemiatrophy: limb hypoplasia

#### Developmental and Genetic

Osteopetrosis: rare; diaphysis remains filled with bone, marrow does not form, fragile bones

Osteogenesis imperfecta: heritable diseases—fragile bones

Mucopolysaccharidosis: rare lysosomal storage disease—Siamese cats—causes dwarfism, facial dysmorphism

Dwarfism

- Osteochondrodysplasias
- Pituitary dwarfism
- Congenital hypothyroidism

Retained cartilage cores

Craniomandibular osteopathy (West Highland White Terrier, Scottish Terrier, Cairn Terrier, Boston Terrier, other terriers)

Multiple cartilaginous exostoses

### Differential Diagnosis: Metabolic, Nutritional, Endocrine, Idiopathic

#### Metabolic

Nutritional secondary hyperparathyroidism

Lead poisoning

#### Nutritional

Rickets (hypovitaminosis D)

Renal osteodystrophy

Hypervitaminosis A: causes osteopathy

Hypovitaminosis A: deformed bones secondary to impedance of bone remodeling

Hypervitaminosis D: skeletal demineralization

Zinc-responsive chondrodysplasia

Copper deficiency

Overnutrition of growing dogs

#### Endocrine

Primary hyperparathyroidism

Humoral hypercalcemia of malignancy

Hyperadrenocorticism

Hypogonadism: delay in physis closure after early gonadectomy

Hepatic osteodystrophy

Anticonvulsant osteodystrophy

#### Idiopathic

Enostosis (panosteitis)

Metaphyseal osteopathy (hypertrophic osteodystrophy)

Avascular necrosis of femoral head (Legg–Calvé–Perthes disease)

Secondary hypertrophic osteopathy (usually in response to thoracic neoplasia)  
Medullary bone infarction  
Bone cyst  
Aneurysmal bone cyst  
Subchondral bone cyst  
Fibrous dysplasia  
Central giant cell granuloma

---

## SECTION IX

# Liver and Exocrine Pancreatic Disorders

---

Cholangitis and Cholangiohepatitis, Feline  
Exocrine Pancreatic Disease  
Gallbladder and Extrahepatic Biliary Disease  
Hepatic Encephalopathy  
Hepatic Lipidosis, Feline  
Hepatobiliary Disease  
Hepatomegaly and Microhepatica  
Hyperlipidemia  
Pancreatitis  
Portosystemic Shunt, Congenital and Acquired  
Vacuolar Hepatopathy, Canine

## **Cholangitis and Cholangiohepatitis, Feline**

### **Comparative Clinical Findings**

#### **Suppurative (Neutrophilic) Cholangitis and Cholangiohepatitis**

Middle-aged to older cats  
Often depressed and ill  
Anorexia (usually)  
Vomiting  
Abdominal discomfort  
Jaundice  
Neutrophilia  
Increased ALT  
Increased ALP  
Increased bilirubin ( $\pm$ )  
Increased serum and urine bile acids ( $\pm$ )  
Hyperechoic liver and bile stasis  
Primarily neutrophilic infiltrate  
Lesions surround bile ducts  
May be associated with pancreatitis and/or inflammatory bowel disease  
Respond to antibiotics and supportive nonspecific treatments

#### **Lymphocytic Cholangitis**

Younger cats  
Persians  
Bright and alert  
Polyphagia ( $\pm$ )  
Ascites ( $\pm$ )  
Icterus ( $\pm$ )  
Fever ( $\pm$ )  
Lymphadenopathy ( $\pm$ )  
Hepatomegaly ( $\pm$ )  
Neutrophilia ( $\pm$ )  
Lymphopenia ( $\pm$ )  
Bile acids ( $\pm$ )  
Increased ALT  
Increased ALP  
Bilirubinemia/bilirubinuria ( $\pm$ )  
Hyperglobulinemia  
Hyperechoic liver ( $\pm$ )  
Primarily lymphocytic infiltrate  
Lesions found in portal areas  
Variable fibrosis  
Pancreatitis (may be present)  
Positive response to immunosuppressive corticosteroids

# Exocrine Pancreatic Disease

## Differential Diagnosis

Pancreatitis

- Acute
- Chronic

Exocrine pancreatic insufficiency

Pancreatic pseudocyst

Pancreatic abscess

Exocrine pancreatic neoplasia

- Pancreatic adenoma
- Pancreatic adenocarcinoma
- Pancreatic sarcoma (spindle cell sarcoma, lymphosarcoma) rare

Nodular hyperplasia

Pancreatic parasites (cats)

- *Eurytrema procyonis* (pancreatic fluke)
- *Amphimerus pseudofelineus* (hepatic fluke)

Pancreatic bladder

- Abnormal extension of pancreatic duct (rare finding in cat)

## Clinical Findings of Exocrine Pancreatic Insufficiency

Most often seen in young to middle-aged dogs; German Shepherds are predisposed, less common but is seen in cats

Chronic weight loss

Ravenous appetite

Coprophagia

Pica

Change in fecal character

- Voluminous
- Soft
- Watery
- Color change
- May be normal

Poor hair coat quality

Borborygmus, flatulence

Coagulation disorder (caused by malabsorption of vitamin K, rare)

# Gallbladder and Extrahepatic Biliary Disease

## Differential Diagnosis

### Obstructive Disease

Extrahepatic biliary obstruction

- Pancreatitis (most common etiology in dog)
- Biliary neoplasia
- Cholangitis
- Pancreatic neoplasia

Cholelithiasis/choledocholithiasis

Gallbladder mucocele

### Nonobstructive Disease

Cholecystitis

- Bacterial cholecystitis (ascending infection—*Escherichia coli* most common)
- Necrotizing cholecystitis
- Emphysematous cholecystitis (*E. coli*, *Clostridium perfringens*)

Cholelithiasis/choledocholithiasis (does not always cause obstruction)

Parasites (mainly seen in cats)

Tropical climates (seen in cats that eat lizards or toads)

- *Platynosomum fastosum* (a fluke)
- *Amphimerus pseudofelineus*
- *Metorchis conjunctus*
- *Eurytrema procyonis*

Gallbladder infarct

### Neoplasia

Biliary cystadenoma

Bile duct carcinoma

### Caroli Disease

Dilatation of intrahepatic and extrahepatic bile ducts

### Gallbladder Rupture

Necrotizing cholecystitis

Obstruction

Iatrogenic

Blunt abdominal trauma

Gallbladder torsion

Dogs with hypothyroidism and hyperadrenocorticism may be predisposed to infarct/rupture

## Clinical Findings of Gallbladder and Biliary Disease

### Clinical Signs

Vomiting

Icterus

Anorexia

Fever

Abdominal pain

Depression

Weight loss

Ascites/bile peritonitis

### Clinicopathologic Findings



- Hyperbilirubinemia
- Elevated ALP levels
- Elevated gamma glutamyltransferase (GGT) levels
- Elevated serum bile acids
- Elevated ALT levels
- Hypercholesterolemia
- Stress leukogram
- Nonregenerative anemia

### **Radiographic Findings**

- Hepatomegaly
- Mass effect in area of gallbladder
- Gas shadow in area of gallbladder
- Choleliths radiopaque if they contain calcium (50% may not be seen on radiographs)

### **Ultrasonographic Signs**

- Dilated and tortuous bile ducts
- Gallbladder distension
- Thickened gallbladder wall
- Cholelith visible
- Pancreatic mass identified
- Stellate appearance to contents of gallbladder (characteristic of a gallbladder mucocele)

# Hepatic Encephalopathy

## Clinical Findings

### General Systemic Clinical Signs

Anorexia  
Depression  
Weight loss  
Lethargy  
Nausea  
Fever  
Ptyalism  
Intermittent vomiting  
Diarrhea  
Polyuria/polydipsia  
Stranguria, pollakiuria, hematuria (biurate urolithiasis)

### CNS Clinical Signs

Tremors  
Ataxia  
Personality change (often toward aggression)  
Dementia  
Head pressing  
Pacing  
Circling  
Hysteria  
Cortical blindness  
Seizures  
Coma

# Hepatic Lipidosis, Feline

## Clinical Findings

### Historical Findings

Obesity

Recent anorexia and rapid weight loss

- Concurrent disease that causes anorexia (pancreatitis, diabetes mellitus, inflammatory hepatobiliary disease, inflammatory bowel disease, FIP, chronic renal failure, neoplasia, cardiomyopathy, neurologic disease, etc.)
- Stressful event
- Abrupt diet change

Typically indoor cats

### Physical Findings

Jaundice

Vomiting

Dehydration

Hepatic encephalopathy

- Depression
- Ptyalism

Hepatomegaly

### Clinicopathologic Findings

Typical findings of cholestasis

- Moderate increase in ALT
- Marked increase in ALP
- Mild increase in GGT; disproportionately low compared with other feline cholestatic hepatopathies
- Elevated serum bile acids typical

Coagulation test abnormalities (especially in conjunction with acute pancreatitis)

Abdominal ultrasound = normal-to-increased liver size, diffusely hyperechoic parenchyma

### Cytology (Ultrasound-Guided Needle Aspirates) and Histopathology

Reveal clear vacuolation of most hepatocytes, nonzonal in distribution; typically with absence of inflammatory cells

# Hepatobiliary Disease

## Clinical and Physical Findings

### General Clinical Features

Depression  
Anorexia  
Lethargy  
Weight loss  
Poor hair coat, insufficient grooming  
Nausea, vomiting  
Diarrhea  
Dehydration  
Small body stature  
Polydipsia, polyuria

### Signs Specific but Not Pathognomonic for Hepatic Disease

Icterus  
Bilirubinuria  
Acholic feces  
Organomegaly  
Ascites  
Hepatic encephalopathy

- Behavioral changes (aggression, dementia, hysteria)
- Circling
- Ataxia
- Staggering
- Pacing
- Head pressing
- Cortical blindness
- Ptyalism
- Tremors/seizures
- Coma

Coagulopathies  
Polydipsia/polyuria

## Causes of Elevated Serum Hepatobiliary Enzymes

### Primary Hepatic Disease

#### Drug Induction

Corticosteroids (dogs)  
Anticonvulsants (phenobarbital, phenytoin, primidone)

#### Endocrinopathies

Hyperadrenocorticism (dogs)  
Hypothyroidism (dogs)  
Hyperthyroidism (cats)  
Diabetes mellitus

#### Bone Disorders

Growing animals  
Osteosarcoma  
Osteomyelitis

## Neoplasia

Adenocarcinomas (pancreatic, intestinal, adrenocortical, mammary)  
Sarcomas (hemangiosarcoma, leiomyosarcoma)  
Hepatic metastasis

## Muscle Injury

Acute muscle necrosis/trauma  
Myopathies  
Malignant hyperthermia

## Hypoxia/Hypotension

Septic shock  
Surgery  
CHF  
Hypoadrenocorticism  
Circulatory shock  
Severe acute blood loss  
Hypotensive crisis  
Status epilepticus

## GI Disease

Pancreatitis  
Inflammatory bowel disease

## Miscellaneous Causes

Systemic infections  
Pregnancy (cats—increased placental ALP)  
Colostrum-fed neonates (dogs)  
Breed related (Scottish Terrier)

## Differential Diagnosis, Dogs

### Inflammation

Chronic hepatitis complex

- Copper accumulation—Bedlington Terrier, Airedale Terrier, Bull Terrier, Bulldog, Cocker Spaniel, Collie, Dachshund, Dalmatian, Doberman Pinscher, German Shepherd, Golden Retriever, Keeshond, Kerry Blue Terrier, Labrador Retriever, Norwich Terrier, Old English Sheepdog, Pekingese, Poodle, Samoyed, Schnauzer, Skye Terrier, West Highland White Terrier, Wire Fox Terrier
- Drug induced: trimethoprim-sulfa, phenobarbital, diethylcarbamazine, oxibendazole, many others
- Familial hepatitis—Doberman Pinscher, West Highland White Terrier, Dalmatian, Skye Terrier, Cocker Spaniel

Fibrosis and cirrhosis (results from any severe or chronic hepatic insult)

Infectious agents: leptospirosis, canine adenovirus type 1 infection, bacterial hepatitis, histoplasmosis, Rocky Mountain spotted fever, ehrlichiosis, babesiosis, leishmaniasis

Cholangiohepatitis

Granulomatous hepatitis

- *Rhodococcus*, *Borrelia*, *Bartonella*, *Histoplasma*, *Coccidioidomyces*, *Hepatozoon*, *Heterobilharzia*, *Nocardia*, *Mycobacterium* spp.

Acidophil cell hepatitis

Lobular dissecting hepatitis

Hepatic abscess

## Acute Toxic or Drug-Induced Hepatopathy

## **Vacuolar Hepatopathy**

### **Metabolic Liver Disease**

Amyloidosis  
Hyperlipidemia  
Lysosomal storage disease

### **Vascular Hepatic Disease**

Congenital portosystemic venous anomaly  
Intrahepatic portal vein hypoplasia  
Intrahepatic arteriovenous fistula

### **Biliary Tract Disease**

#### **Neoplasia**

Primary: hepatocellular carcinoma, hepatocellular adenoma, hepatic hemangiosarcoma, biliary carcinoma  
Other hepatic tumors: leiomyosarcoma, liposarcoma, myxosarcoma, fibrosarcoma, biliary adenoma, hepatic carcinoid  
Hemolymphatic: lymphosarcoma, MCT, plasma cell tumor  
Metastatic neoplasia

### **Hepatic or Biliary Cysts**

## **Differential Diagnosis, Cats**

### **Hepatic Lipidosis**

#### **Inflammatory Hepatobiliary Disease**

Cholangitis/cholangiohepatitis complex

- Suppurative (neutrophilic) cholangitis, cholangiohepatitis
- Lymphocytic cholangitis

Chronic cholangiohepatitis (later stage of acute cholangiohepatitis)  
Sclerosing cholangitis  
Lymphocytic portal hepatitis  
FIP

#### **Toxic Hepatopathy**

Antimicrobials (trimethoprim-sulfa, tetracycline)  
Anticonvulsants (phenobarbital)  
Diazepam  
Methimazole  
Griseofulvin  
Ketoconazole  
Pine oils (cleaning agents)  
NSAIDs  
*Amanita phalloides* (death cap mushroom)  
Natural or herbal remedies  
Many others

### **Portosystemic Venous Anomaly**

### **Lipoprotein Lipase Deficiency**

#### **Neoplasia**

### **Primary Hepatic Neoplasia**

Biliary carcinoma  
Hepatocellular carcinoma  
Hepatic hemangiosarcoma  
Biliary cystadenoma  
Myelolipoma  
Hepatic carcinoid

### **Hemolymphatic Neoplasia**

Lymphosarcoma  
MCT  
Plasma cell tumor

### **Metastatic Neoplasia**

# Hepatomegaly and Microhepatica

## Differential Diagnosis

### Generalized Hepatomegaly

Acute toxic hepatopathy

Infiltrative hepatic disease

- Neoplasia: primary or metastatic
- Chronic hepatitis complex (dog)
- Cholangitis/cholangiohepatitis (cat)
- Extramedullary hematopoiesis
- Mononuclear-phagocytic cell hyperplasia
- Amyloidosis (rare)
- Hepatic lipidosis (cat)

Passive congestion

- Right-sided heart failure
- Pericardial disease (dog)
- Caval syndrome (dog)
- Caudal vena cava obstruction (dog)
- Budd–Chiari syndrome (rare)

Hepatocellular hypertrophy

- Hepatic lipidosis
- Steroid hepatopathy
- Hyperadrenocorticism
- Anticonvulsant drug therapy

Acute extrahepatic bile duct obstruction

### Focal Hepatomegaly

Neoplasia: primary or metastatic

Nodular hyperplasia

Chronic hepatic disease with fibrosis and nodular regeneration

Hepatic abscess

Hepatic cyst

### Microhepatica

Decreased hepatic mass

- Chronic hepatic disease with progressive loss of hepatocytes

Decreased portal blood flow with hepatocellular atrophy

- Congenital portosystemic shunt
- Intrahepatic portal vein hypoplasia
- Chronic portal vein thrombosis

Hypovolemia

- Hypoadrenocorticism
- Shock



# Hyperlipidemia

## Differential Diagnosis

### Postprandial Hyperlipidemia

#### Primary

Idiopathic hyperlipoproteinemia of Miniature Schnauzers  
Feline familial hyperchylomicronemia  
Idiopathic hypercholesterolemia (rare—Doberman Pinscher, Rottweiler)  
Idiopathic hypercholesterolemia

#### Secondary

Endocrine

- Hypothyroidism
- Diabetes mellitus
- Hyperadrenocorticism

Pancreatitis  
Nephrotic syndrome  
Hepatic insufficiency  
Cholestasis  
Drug induced

- Glucocorticoids
- Megestrol acetate

## Clinical Findings

### Severe Hyperlipidemia

Intermittent GI signs

- Vomiting
- Diarrhea
- Abdominal discomfort

Seizures  
Pancreatitis  
Lipemia retinalis  
Uveitis  
Cutaneous xanthomas  
Peripheral nerve paralysis  
Behavioral changes

### Severe Hypercholesterolemia

Arcus lipoides corneae  
Lipemia retinalis  
Atherosclerosis

# Pancreatitis

## Clinical Findings of Acute Pancreatitis

### Dogs

#### Mild Acute Pancreatitis

Depression  
Anorexia  
Nausea, vomiting, diarrhea  
Ptyalism  
Mild right cranial abdominal pain  
Fever, dehydration, weakness

#### Moderate-to-Severe Acute Pancreatitis

Depression  
Anorexia  
Vomiting  
Right cranial abdominal pain  
Hematemesis, hematochezia, melena  
Jaundice  
Respiratory distress  
Shock, fever, dehydration  
Hyperemic mucous membranes  
Tachycardia, tachypnea  
Abdominal effusion  
Mass effect in region of pancreas  
Petechiae, ecchymoses  
Cardiac arrhythmia  
Glossitis, glossal slough  
Extrahepatic biliary obstruction

### Cats

Signs tend to be more subclinical and nonspecific.  
May be associated with inflammatory bowel disease  
May be component of multisystemic disease such as toxoplasmosis  
Lethargy, anorexia, vomiting, dehydration, weight loss, jaundice, hypothermia  
Rarely icterus, abdominal pain  
May present as acute necrotizing or acute suppurative form

## Predisposing Factors

### Nutritional

Obesity  
High-fat diet  
After ingestion of large, fatty meal

### Hypertriglyceridemia

### Hyperlipoproteinemia (Idiopathic in Miniature Schnauzers)

Endocrine (diabetes mellitus, hyperadrenocorticism, hypothyroidism)

### Drugs

Chemotherapeutic agents  
• L-Asparaginase

- Azathioprine
- Others

Organophosphates  
 Asparaginase  
 Thiazides  
 Furosemide  
 Estrogens  
 Sulfa drugs  
 Phenobarbital  
 Procainamide  
 Potassium bromide  
 Tetracyclines

### Ischemia

Hypovolemia  
 Associated with DIC  
 Vasoactive amine-induced vasoconstriction  
 Surgery  
 Gastric dilatation/volvulus  
 Severe immune-mediated hemolytic anemia

### Duodenal Reflux

Increased intraluminal pressure during severe vomiting

### Other

Cholangitis  
 Infection (toxoplasmosis, FIP)  
 Abdominal trauma  
 Hypercalcemia  
 Trauma

## Clinicopathologic Findings in Dogs and Cats with Acute Pancreatitis

- BUN/creatinine—increased in 50%-65% of dogs and in 33% (Cr) and 57% (BUN) in cats. Usually prerenal due to dehydration and hypotension. May be secondary to intrinsic renal failure (sepsis and immune-complex).
- Potassium—decreased in 20% of cases in dogs and 56% in cats. Increased loss in vomiting and due to renal loss with fluid therapy plus reduced intake and aldosterone release caused by hypovolemia.
- Sodium—can be increased, decreased, or normal. Increase usually caused by dehydration, decrease caused by losses secondary to vomiting.
- Calcium—commonly decreased in cats, rarely in dogs, rarely increased in both dogs and cats. Reduction is a poor prognostic indicator in cats, but has no prognostic significance in dogs. May be caused by saponification in peripancreatic fat and glucagon release stimulating calcitonin.
- Chloride—very commonly decreased in dogs. Loss in GI secretions in vomiting.
- Phosphate—often increased in dogs; uncommonly increased or decreased in cats. Increase usually due to reduced renal excretion secondary to renal compromise. Decrease (in cats) due to treatment for diabetes mellitus.
- Glucose—increased in 40%-88% of dogs and decreased in up to 40%. Increased in 64% of cats, rarely decreased. Increase due to decreased insulin and increased glucagon, cortisol, and catecholamines. Decrease caused by sepsis or anorexia.
- Albumin—increased in 39%-50% and decreased in 17% of dogs. Increased in 8%-30% and decreased in 40% of cats. Increase due to dehydration. Decrease due to gut loss, malnutrition, concurrent hepatic disease, or renal loss.
- Hepatocellular enzymes (ALT, AST)—increased in 61% of dogs and 68% of cats. Hepatic

necrosis and vacuolation due to sepsis, local effects of pancreatitis +/- concurrent hepatic disease in cats.

- Cholestatic enzymes (ALP and GGT)—increased in 79% of dogs and 50% of cats. Biliary obstruction due to acute or chronic pancreatitis +/- concurrent cholangitis +/- lipidosis in cats; steroid-induced ALP in dogs.
- Bilirubin—increased in 53% of dogs and 64% of cats (same causes as GGT and ALP).
- Cholesterol—increased in 48%-80% of dogs and 64% of cats. Can be due to cholestasis; unclear if cause or effect.
- Triglycerides—commonly increased in dogs. Unclear if cause or effect.
- Neutrophils—increased in 55%-60% of dogs, increased in 30% and decreased in 15% of cats. Increased due to inflammatory response. Decreased in some cats due to consumption, may be a poor prognostic indicator.
- Hematocrit—increased in about 20% and decreased in 20% of both dogs and cats. Increased due to dehydration and decreased due to anemia of chronic disease or gastric ulceration.
- Platelets—commonly decreased in severe cases in dogs. Decreased due to circulating proteases +/- DIC.

## **Portosystemic Shunt, Congenital and Acquired**

**Congenital—May be Intrahepatic (More Common in Large Breed Dogs) or Extrahepatic (More Common in Small Dogs and Cats)**

**Acquired—No Breed or Gender Predilection**

### **Clinical Findings**

#### **Signalment**

Young animal, male or female, often purebred

#### **History**

Neurologic signs (dementia, circling, central blindness, personality change, head pressing, wall hugging, seizures)

Vomiting

Diarrhea

Ptyalism (especially cats)

Worsening of signs after eating

Improvement of signs with antimicrobial therapy

Prolonged recovery from anesthesia

Polydipsia/polyuria

Recurrent urate urolithiasis in breeds other than Dalmatian and English Bulldog

#### **Physical Examination**

Poor hair coat

Small stature

Cystic calculi

Cryptorchidism

Bilateral renomegaly

Copper-colored irises in non-Asian cat breeds

Other congenital anomalies

#### **Clinicopathologic Findings**

Microcytosis

Hypoalbuminemia

Mild increases in hepatic enzymes

Hypocholesterolemia

Low BUN

Normal-to-high resting bile acids/elevated postprandial bile acids

Hyposthenuria

Urate crystalluria and urolithiasis

# Vacuolar Hepatopathy, Canine

## Differential Diagnosis

Hyperadrenocorticism

- Pituitary dependent
- Adrenal dependent
- Iatrogenic (glucocorticoid therapy)

Pancreatitis

- Chronic

Severe hypothyroidism

Chronic stress

- Illness of more than 4 months

Chronic infection or inflammation (e.g., pyelonephritis, chronic dermatitis)

Severe dental disease

- Oral infection

Disorders affecting lipid metabolism

- Diabetes mellitus
- Idiopathic hyperlipidemia

Neoplasia

- Lymphoma

CHF

Abnormal sex hormone production

Inflammatory bowel disease

- Chronic, lymphoplasmacytic, eosinophilic

Hepatocutaneous syndrome

---

## SECTION X

# Neoplasia

---

Chemotherapeutic Agent Toxicity  
Corticosteroid Therapy  
Histiocytic Disease  
Humoral Hypercalcemia  
Lymphoma  
Paraneoplastic Syndromes  
Sarcomas  
Thyroid Neoplasms  
Tumors

# Chemotherapeutic Agent Toxicity

Most severely affects tissues with a growth fraction that approaches that of tumor cells

## Clinical Findings

### Myelosuppression

Neutropenia: short-lived cells; nadir is 5-10 days postchemotherapy

Thrombocytopenia: nadir is 7-14 days postchemotherapy

Anemia: erythrocytes live longer; rarely clinically significant

### GI Toxicity

Nausea, vomiting

Diarrhea

Inappetence

Anorexia

### Cardiotoxicity

Doxorubicin therapy

Breeds susceptible to dilated cardiomyopathy (e.g., Doberman) most sensitive

Most likely after cumulative dose of 180 mg/m<sup>2</sup>

### Nephrotoxicity

Cisplatin, streptozotocin

Limit use of cisplatin in cases of preexisting renal disease.

### Hepatopathy

Irreversible hepatic toxicity may result if lomustine (CCNU) given in face of elevated ALT

### Urothelial Toxicity

Sterile hemorrhagic cystitis

Cyclophosphamide, ifosfamide

### Extravasation

Doxorubicin: severe local reaction leading to slough

Vincristine: usually minor tissue damage

### Hypersensitivity

Doxorubicin: caused by histamine release from mast cells; prevented by slow administration

L-Asparaginase: less likely if given subcutaneously rather than intravenously

Etoposide, paclitaxel: caused by carrier solutions for these agents

### Alopecia

Less of a problem in dogs and cats than in people

Worse in breeds that have hair (e.g., Poodles, terriers, Old English Sheepdogs) than in dogs with fur

Loss of "feathers" (e.g., Golden Retrievers)

Loss of whiskers in cats

### Pancreatitis

### Neurologic Toxicity

Fatal neurotoxicity in cats with topical or systemic administration of 5-fluorouracil



## **Respiratory Toxicity**

Fatal, acute pulmonary edema in cats with cisplatin therapy

## Corticosteroid Therapy

### Adverse Effects Associated with Glucocorticoid Administration

Polyuria/polydipsia  
Polyphagia  
Increased ALP levels  
Increased GGT levels  
Panting  
Insomnia, agitation, behavioral changes  
Immunosuppression

- Secondary infection
- Recrudescence of latent infection
- Worsening of existing infection
- Demodicosis

Vacuolar hepatopathy  
Iatrogenic hyperadrenocorticism  
Adrenocorticoid deficiency with rapid withdrawal after sustained use  
Alopecia  
Calcinosis cutis  
Comedones  
Skin thinning  
Proteinuria  
Muscle atrophy/muscle wasting  
Myotonia/myopathy  
Delayed wound healing  
Colonic perforation  
GI ulceration  
Insulin resistance  
Diabetes mellitus  
Hyperlipidemia  
Abortion  
Growth suppression  
Hypercoagulable state  
Ligament and tendon rupture  
Psychosis/behavior change  
Lowered seizure threshold  
Osteopenia

# Histiocytic Disease

## Classification, Dogs

May be difficult to differentiate from lymphoproliferative, granulomatous, or reactive inflammatory disease by histopathology alone

### Cutaneous Histiocytoma

Benign, usually solitary lesion  
Typically young dogs  
Often spontaneously regress

### Langerhans Cell Histiocytoma

Rare, rapidly metastatic, cutaneous infiltration by histiocytes, may be limited to multiple cutaneous sites or may affect lymph nodes and internal organs

### Cutaneous Histiocytosis

Single or multiple lesions  
May spontaneously regress  
May respond to immunosuppressive drugs

### Systemic Histiocytosis

Familial disease of Bernese Mountain Dogs, rarely other breeds  
Similar lesions to cutaneous histiocytosis, but may also affect mucous membranes, lymphoid organs, lung, bone marrow, and other organ systems  
Progressive, requires immunosuppressive therapy

### Histiocytic Sarcoma

Bernese Mountain Dog, Rottweiler, Flat-Coated Retriever, Golden Retriever, rarely other breeds  
Histiocytic sarcoma usually begins as a localized lesion in spleen, lymph nodes, lung, bone marrow, skin and subcutis, brain, and periarticular tissue of appendicular joints.

- Rapidly disseminates to multiple organs

### Malignant Histiocytosis

Bernese Mountain Dog, Rottweiler, Flat-Coated Retriever, Golden Retriever, rarely other breeds  
Multisystemic, rapidly progressive disease of multiple organs

## Classification, Cats

### Feline Progressive Histiocytosis

Rare, usually see multiple skin nodules, papules, plaques  
Head, lower extremities, trunk  
Poor long-term prognosis

### Feline Histiocytic Sarcoma

Poorly demarcated tumors of subcutis or spleen  
Poor prognosis

# Humoral Hypercalcemia

## Differential Diagnosis

### Hematologic Cancers

- Lymphosarcoma
- Lymphocytic leukemia
- Myeloproliferative disease
- Myeloma

### Solid Tumors with Bone Metastasis

- Mammary adenocarcinoma
- Nasal adenocarcinoma
- Epithelial-derived tumors
- Pancreatic adenocarcinoma
- Lung carcinoma

### Solid Tumors without Bone Metastasis

- Apocrine gland adenocarcinoma of the anal sac
- Interstitial cell tumor
- Squamous cell carcinoma
- Thyroid adenocarcinoma
- Lung carcinoma
- Pancreatic adenocarcinoma
- Fibrosarcoma

# Lymphoma

## Common Differential Diagnoses

### Generalized Lymphadenopathy

Disseminated infections

- Bacterial, fungal, rickettsial, parasitic, viral

Immune-mediated disease

- SLE, polyarthritis, vasculitis, dermatopathy

Other hematopoietic tumors

- Leukemia, multiple myeloma, malignant or systemic histiocytosis, systemic mastocytosis

Neoplasia metastatic to lymph nodes

Benign reactive hyperplastic syndromes in cats

### Alimentary Disease

Inflammatory bowel diseases

- Lymphocytic/plasmacytic, eosinophilic enteritis

Nonlymphoid intestinal neoplasia

Granulomatous enteritis

Granulated round cell tumors in cats

GI mast cell neoplasia in cats

GI eosinophilic sclerosing fibrosis

### Cutaneous Disease

Infectious dermatitis (deep pyoderma, fungal dermatitis)

Immune-mediated dermatitis (e.g., pemphigus foliaceus)

Other cutaneous neoplasms

### Mediastinal Disease

Thymoma

Chemodectoma (heart base tumor)

Ectopic thyroid neoplasia

Pulmonary lymphomatoid granulomatosis

Granulomatous disease (e.g., hilar lymphadenopathy with blastomycosis)

# Paraneoplastic Syndromes

## Classification

### General

Cancer anorexia, cachexia

Fever

### Hematologic

Anemia

- Anemia of chronic disease
- Immune-mediated hemolytic anemia
- Bone marrow infiltration
- Blood loss anemia
- Hyperestrogenism
- Microangiopathic hemolytic anemia

Polycythemia (rare)

- Associated with renal neoplasia, nasal fibrosarcoma, lymphoma, bronchial carcinoma, cecal leiomyosarcoma, transmissible venereal tumor, soft tissue sarcoma

Leukocytosis

- Neutrophilic
- Eosinophilic

Thrombocytopenia

- Increased consumption
- Decreased production (bone marrow neoplasia)
- Increased destruction (immune-mediated thrombocytopenia)

Thrombocytosis

Thrombocyte hyperaggregability/hypercoagulability

Pancytopenia

Coagulation disorders

- DIC
- Coagulation-activating substances produced by tumor

Hyperproteinemia/hyperglobulinemia

### Endocrine

Hypercalcemia of malignancy

Hypoglycemia

Syndrome of inappropriate ADH secretion

- Hyponatremia, serum
- Hypoosmolality, urine
- Hyperosmolality

Hyperestrogenism (Sertoli cell tumor)

Ectopic ACTH

### GI

Gastroduodenal ulceration

- MCTs, gastrinoma

Cancer cachexia

### Renal

Glomerulonephritis

Hypercalcemic nephropathy

### Cutaneous

Superficial necrolytic dermatitis

Nodular dermatofibrosis  
Feline paraneoplastic alopecia  
Flushing (MCT, pheochromocytoma)

### **Neuromuscular**

Myasthenia gravis

- Dogs with thymoma

Peripheral neuropathy

- Multiple myeloma, lymphoma, insulinoma, various carcinomas and sarcomas

### **Hypertrophic Osteopathy**

Space-occupying mass in thorax or rarely abdomen

## Sarcomas

### Classification of Soft Tissue Sarcomas

Fibrosarcoma  
MCT  
Undifferentiated sarcoma  
Hemangiosarcoma  
Hemangiopericytoma (peripheral nerve-sheath tumor)  
Myxosarcoma  
Leiomyosarcoma  
Malignant fibrous histiocytoma  
Schwannoma  
Neurofibrosarcoma  
Synovial cell sarcoma  
Rhabdomyosarcoma  
Liposarcoma  
Vaccine-associated fibrosarcoma (cats)

### Clinical Findings for Hemangiosarcoma

Older dogs and cats  
Many potential sites of origin

- Spleen
- Right atrium
- Subcutis
- Pericardium
- Liver
- Muscle
- Lung
- Skin
- Bone
- Kidney
- CNS
- Peritoneum
- Oral cavity
- Nasal cavity
- Eye
- Retroperitoneum

Hemoabdomen  
Pericardial effusion  
Cardiac tamponade  
Sudden death  
Anorexia, vomiting  
Lethargy  
Right-sided heart failure  
Muffled heart sounds  
Arrhythmias  
Neurologic signs (may metastasize to brain)



# Thyroid Neoplasms

## Classification and Clinical Findings

### Cats

Hyperthyroidism: functional thyroid tumors

- Thyroid adenoma
- Thyroid adenocarcinoma

### Dogs

Nonfunctional tumors (90%)

Thyroid adenoma

Thyroid adenocarcinoma

- Swelling or mass in neck
- Dyspnea
- Cough
- Lethargy
- Dysphagia
- Regurgitation
- Anorexia
- Weight loss
- Horner syndrome
- Change in bark
- Facial edema

Functional tumors (10%)

Thyroid adenoma

Thyroid adenocarcinoma

- Swelling or mass in neck
- Polyphagia/weight
- Hyperactivity
- Polyuria/polydipsia
- Panting
- Change in behavior (aggression)

## Tumors

### Bone and Joint Tumors, Classification

Canine osteosarcoma

- Appendicular
- Skull
- Scapular
- Pelvic
- Ribs
- Vertebral
- Nasal and paranasal

Chondrosarcoma

Fibrosarcoma

Hemangiosarcoma

Multilobular osteochondrosarcoma

Osteoma

Canine multiple cartilaginous exostoses

Feline osteosarcoma

Feline multiple cartilaginous exostoses

Metastatic bone tumors

- Transitional cell carcinoma
- Prostatic adenocarcinoma
- Mammary carcinoma
- Thyroid carcinoma
- Pulmonary carcinoma
- Nasal carcinoma
- Apocrine gland, anal sac adenocarcinoma
- Renal tumors
- Others

Primary joint tumors

- Synovial cell sarcoma
- Histiocytic sarcoma
- Malignant fibrous histiocytoma
- Synovial myxoma
- Myxosarcoma
- Osteosarcoma
- Fibrosarcoma
- Chondrosarcoma
- Hemangiosarcoma
- Liposarcoma
- Rhabdomyosarcoma
- Undifferentiated sarcoma

### Hematopoietic Tumors, Classification

#### Lymphoma

##### Feline

Alimentary

Multicentric

Mediastinal/thymic

Nasal

Renal

Spinal

Other

FeLV associated

## **Canine**

Multicentric

Others (alimentary, mediastinal, cutaneous)

## **Lymphoid Leukemia**

Acute lymphoblastic leukemia (in cats, often associated with FeLV infection)

Chronic lymphocytic leukemia

## **Nonlymphoid Leukemias and Myeloproliferative Disorders**

Acute myelogenous leukemia (myeloblastic)

Acute myelomonocytic leukemia (myeloblasts/monoblasts)

Acute monocytic leukemia (monoblasts)

Acute megakaryoblastic leukemia (megakaryoblasts)

Erythroleukemia (erythroblasts)

## **Chronic Myeloproliferative Disorders**

Chronic myelogenous leukemia (neutrophils, late precursors)

Primary thrombocythemia (platelets)

Basophilic leukemia (basophils and precursors)

Eosinophilic leukemia (eosinophils and precursors)

Polycythemia vera (erythrocytes)

Mast cell leukemia

## **Plasma Cell Neoplasms**

Multiple myeloma

Solitary plasmacytoma

IgM (Waldenström macroglobulinemia)

## **MCT Disease, Clinical Findings**

### **Clinical Appearance and Location of MCTs**

Extremely variable in appearance

Soft, fluctuant, firm, discrete, diffuse, small, large, solitary, multiple, haired, hairless, dermal, or subcutaneous

Erythema, bruising, ulceration

On trunk most often; also perineum, extremities, head, neck

May shrink or swell due to degranulation

Rarely oral cavity, nasal cavity, larynx, conjunctiva

### **Systemic Signs of Disseminated Mastocytosis**

GI ulceration

Abdominal discomfort

Vomiting

Melena

Hypotension

Coagulation abnormalities

Acute or chronic blood loss anemia

## **Oral Cavity Tumors, Differential Diagnosis**

### **Malignant Neoplasms**

Melanoma

Squamous cell carcinoma

Fibrosarcoma  
Osteosarcoma  
Lingual carcinoma or sarcoma  
Histiocytic sarcoma  
Lymphoma  
MCT

## Benign Neoplasms

Epulides (acanthomatous ameloblastoma)

- Peripheral odontogenic fibroma (replaces the terms *fibromatous epulis* and *ossifying epulis*)
- Acanthomatous ameloblastoma (replaces the term *ossifying epulis*): may be invasive but does not metastasize
- Giant cell epulis

Papillomas: self-limiting

Fibroma

Lipoma

Chondroma

Osteoma

Odontoma

Cementoma

Plasmacytoma

Hemangioma

Hemangiopericytoma

Histiocytoma

Eosinophilic granuloma

## Skin and Subcutaneous Tumors

### Epithelial Tumors

Sebaceous gland adenoma/adenocarcinoma

Squamous cell carcinoma

- Canine cutaneous squamous cell carcinoma
- Canine nasal planum squamous cell carcinoma
- Canine digital squamous cell carcinoma
- Canine oral squamous cell carcinoma
- Feline cutaneous squamous cell carcinoma (nasal planum, aural/pinnal, periocular, ear canal)
- Feline oral squamous cell carcinoma
- Feline multicentric squamous cell carcinoma in situ (Bowen disease)

Trichoepithelioma

Intracutaneous cornifying epithelioma

Basal cell tumors

- Benign tumors
- Basal carcinoma

Trichoblastoma

Pilomatricoma

Papilloma

Perianal gland tumors (hepatoid gland tumors)

Sweat gland tumors (apocrine gland tumors)

Ceruminous gland tumors

Anal sac, apocrine gland tumors

Follicular stem cell carcinoma

### Round Cell Tumors

Lymphoma

MCT

Histiocytoma

Transmissible venereal tumor (TVT)

Plasmacytoma

## **Melanocytic Tumors**

Melanoma

- Benign (typically melanomas of haired skin and eyelids)
- Malignant (typically those of digit or mucocutaneous junctions)

## **Urogenital Tumors, Classification**

### **Kidney**

Lymphoma (most common renal tumor in cats)

Primary renal carcinoma, adenoma/adenocarcinoma

Cystadenocarcinoma with concurrent nodular dermatofibrosis in German Shepherds

Tumors of embryonic origin (e.g., Wilm tumor)

Nephroblastoma

Transitional cell carcinoma

### **Urinary Bladder**

Older female dogs, West Highland White Terriers, Scottish Terriers, Beagles, Dachshunds, Shetland Sheepdogs

Transitional cell carcinoma

Squamous cell carcinoma

Leiomyosarcoma

Leiomyoma

Rhabdomyosarcoma

Metastatic neoplasia

- Hemangiosarcoma
- Lymphoma
- Extension of prostate neoplasia

### **Prostate**

Prostatic adenocarcinoma

Transitional cell carcinoma

### **Penis and Prepuce**

Prepuce affected by tumors of haired skin seen elsewhere

Penile

- TVT
- Others

### **Testicular Neoplasia**

Cryptorchid dogs are 13.6 times more likely to develop Sertoli cell tumor or seminoma

Sertoli cell tumor (25%-50% are functional and cause hyperestrogenemia)

Leydig cell (interstitial) tumor

Seminoma

### **Vagina and Vulva**

Leiomyoma

Fibroleiomyoma

Fibroma

Polyps

Lipoma

Leiomyosarcoma (rare)

TVT

### **Uterus**

Leiomyoma  
Leiomyosarcoma  
Uterine adenocarcinoma

## **Ovary**

### **Epithelial Tumors (50% of ovarian tumors)**

Papillary adenoma  
Cystadenoma  
Papillary adenocarcinoma  
Undifferentiated adenocarcinoma

### **Germ Cell Tumors (10% of ovarian tumors)**

Dysgerminoma  
Teratoma  
Teratocarcinoma

### **Sex-Cord Stromal Tumors (40% of ovarian tumors)**

Granulosa cell tumor  
Benign thecoma  
Benign luteoma  
Sertoli–Leydig cell tumor

## **Mammary Gland**

Fibroadenoma (mixed mammary tumor)  
Solid carcinomas  
Tubular adenocarcinoma  
Sarcoma  
Inflammatory carcinomas  
Feline mammary adenocarcinomas

---

## SECTION XI

# Neurologic and Neuromuscular Disorders

---

Brain Disease, Congenital or Hereditary  
Cognitive Dysfunction  
Cranial Nerve Deficits  
Head Tilt  
Inflammatory Disease of the Nervous System  
Intracranial Neoplasms  
Myasthenia Gravis  
Myositis and Myopathies  
Neurologic Examination  
Paroxysmal Disorders Confused with Epileptic Seizures  
Peripheral Neuropathies  
Spinal Cord Disease  
Spinal Cord Lesions  
Systemic Disease  
Vestibular Disease



# Brain Disease, Congenital or Hereditary

## Differential Diagnosis

### Congenital Malformations

Failure of normal closure of neural tube: vary in severity from clinically inapparent (agenesis of corpus callosum) to severe (anencephaly)

Lissencephaly: failure of normal migration of neurons in development of cerebral cortex; leads to abnormal appearance of sulci and gyri (most often seen in Lhasa Apso)

Cerebellar hypoplasia: seen most often in cats after in utero panleukopenia infection; rarely seen with parvovirus infection of developing cerebellum in dogs; may be isolated malformation without infection

Chiari-like malformations: protrusion of cerebellar vermis through foramen magnum (Cavalier King Charles Spaniel, other dog breeds)

Hydrocephalus: congenital hydrocephalus seen most often in toy and brachycephalic breeds; suggests hereditary basis; often congenital stenosis or aplasia of mesencephalic aqueducts

Inborn errors of metabolism (hereditary): young, purebred animals with diffuse, symmetric signs of brain disease

- Organic acidurias
- Spongiform encephalopathies: may be hereditary or acquired (transmissible) disease
- Polioencephalopathies: metabolic defects that affect gray matter
- Neuroaxonal dystrophy: spheroids causing swelling within axons
- Leukoencephalopathies: disorders of myelin; affect white matter; often affect cerebellum and long tracts leading to tremors and dysmetria
- Lysosomal storage diseases: accumulation of metabolic products in lysosomes
- Ceroid lipofuscinosis: accumulation of proteins in lysosomes
- Neonatal encephalopathy: hereditary disease of standard Poodles

### Movement Disorders

Hereditary cerebellar hypoplasia

Multisystem degeneration: diseases of cerebellum and basal ganglia—progressive neuronal abiotrophy of Kerry Blue Terriers and Chinese Crested Dogs

Dyskinesias and dystonias

Paroxysmal dyskinesias (“Scotty cramp” or idiopathic cerebellitis)—Scottish Terriers

# Cognitive Dysfunction

## Clinical Findings

Disorientation

Sleep/wake cycle alterations

House soiling problems

Change in activity levels

- Increased
- Stereotypic
- Decreased

Agitation

Anxiety

Altered responsiveness to stimuli

- Heightened
- Reduced

Changes in appetite

- Increased
- Decreased

Decreased ability to perform learned tasks

Changes in interaction with owners/other pets

# Cranial Nerve Deficits

## Clinical Findings

### **CN I (Olfactory)**

Loss of ability to smell

### **CN II (Optic)**

Loss of vision, loss of menace response, dilated pupil, loss of papillary light reflex (direct and consensual)

### **CN III (Oculomotor)**

Loss of papillary light reflex on affected side (even if light shone in opposite eye), dilated pupil, ptosis, ventrolateral strabismus

### **CN IV (Trochlear)**

Slight dorsomedial eye rotation

### **CN V (Trigeminal)**

Atrophy of temporalis and masseter muscles, loss of jaw tone and strength, dropped jaw (if bilateral), analgesia of innervated areas

### **CN VI (Abducens)**

Medial strabismus, impaired lateral gaze, poor retraction of globe

### **CN VII (Facial)**

Lip, eyelid, and ear droop; loss of ability to blink; loss of ability to retract lip; possibly decreased tear production

### **CN VIII (Vestibulocochlear)**

Ataxia, head tilt, nystagmus, deafness, positional strabismus

### **CN IX (Glossopharyngeal)**

Loss of gag reflex, dysphagia

### **CN X (Vagus)**

Loss of gag reflex, laryngeal paralysis, dysphagia, megaesophagus

### **CN XI (Accessory)**

Atrophy of trapezius, sternocephalicus, and brachiocephalicus muscles

### **CN XII (Hypoglossal)**

Loss of tongue strength, inability to retract tongue if bilateral, atrophy of tongue

## Head Tilt

### Differential Diagnosis

#### Peripheral Vestibular Disease

Otitis media/interna

Feline idiopathic vestibular disease

Geriatric canine vestibular disease

Feline nasopharyngeal polyps

Middle ear tumor

- Ceruminous gland adenocarcinoma
- Squamous cell carcinoma

Trauma

Aminoglycoside ototoxicity/chemical ototoxicity

Hypothyroidism (possibly)

Post-external ear cleaning/middle ear surgery

#### Central Vestibular Disease

Trauma/hemorrhage

Infectious inflammatory disease

- Rocky Mountain spotted fever
- FIP
- Others

Granulomatous meningoencephalitis, necrotizing meningoencephalitis

Neoplasia

Vascular infarct

Thiamine deficiency

Metronidazole toxicity

# Inflammatory Disease of the Nervous System

## Differential Diagnosis

Steroid-responsive meningitis-arteritis (steroid-responsive suppurative meningitis) (juvenile to young adult large breed

Dogs: Bernese Mountain Dogs, Boxers, German Shorthaired Pointers, Nova Scotia Duck Tolling Retrievers)

Granulomatous meningoencephalitis

- Idiopathic inflammatory brain disease of dogs
- Most commonly in small breed dogs

Pug meningoencephalitis

- Necrotizing meningoencephalitis of cerebral cortex
- Maltese and Yorkshire Terrier also

Feline polioencephalomyelitis

- Young cats, progressive course

FIV encephalopathy

Bacterial meningitis and myelitis

- *Staphylococcus aureus*
- *Staphylococcus epidermidis*
- *Staphylococcus albus*
- *Pasteurella multocida*
- *Actinomyces*
- *Nocardia*
- Others

Canine distemper virus

Rabies

FIP

Toxoplasmosis

Neosporosis

Borreliosis

Mycotic infections

- *Cryptococcus neoformans*, *C. gattii*
- Other disseminated systemic mycoses

Rickettsial diseases

- Rocky Mountain spotted fever
- Ehrlichiosis
- *Ehrlichia ewingii*, *Anaplasma phagocytophylum*

Parasitic meningitis, myelitis, encephalitis

- Aberrant parasite migration

# Intracranial Neoplasms

## Differential Diagnosis

### Meningioma

Benign tumor of cells of meninges

### Neuroepithelial Tumors

Gliomas (astrocytomas, oligodendrogliomas)

Choroid plexus tumors (choroid plexus papilloma, ependymal tumor)

### CNS Lymphoma

Primary: neoplasia of native CNS lymphocytes

Secondary: metastasis of systemic lymphoma

### Metastatic Neoplasia to CNS

Local invasion: nasal adenocarcinoma

Hematogenous spread: melanoma, hemangiosarcoma, lymphosarcoma

Many other neoplasms may metastasize to CNS.

### Pituitary Tumors

Functional tumors of pars distalis or pars intermedius: cause pituitary-dependent hyperadrenocorticism; generally cause little damage to surrounding tissue

Pituitary macrotumor

## Myasthenia Gravis

*Congenital myasthenia gravis*: inherited deficiency of acetylcholine receptors at presynaptic membranes of skeletal muscle

*Acquired myasthenia gravis*: antibodies made against nicotinic acetylcholine receptors of skeletal muscle

### Clinical Findings

Appendicular muscle weakness

- Worsens with exercise
- Improves with rest
- Tetraplegia

Mentation, postural reactions, reflexes normal

Megaesophagus

- Salivation
- Regurgitation

Dysphagia

Ventroflexion

Urinary bladder distension

Hoarse bark or meow

Persistently dilated pupils

Facial muscle weakness

Aspiration pneumonia

Respiratory weakness

# Myositis and Myopathies

## Differential Diagnosis

### Inflammatory Myopathies

Masticatory myositis

- Immunoglobulin G (IgG) antibodies to type 2M myofibers
- German Shepherd, retrievers, and Doberman Pinscher predisposed
- Young to middle-aged dogs

Canine idiopathic polymyositis

- Large-breed dogs predisposed

Feline idiopathic polymyositis

Dermatomyositis

- Herding breeds, especially Shetland Sheepdogs and Collies

Protozoal myositis

- *Toxoplasma gondii*
- *Neospora caninum*, *Hepatozoon*, *Babesia*, *Leishmania*, or *Trypanosoma* infection

Bacterial myositis

- *Clostridium*, *Leptospira*, *Ehrlichia*, Rocky Mountain spotted fever

Extraocular myositis (dogs)

FIV

### Metabolic Myopathies

Glucocorticoid excess

- Hyperadrenocorticism
- Exogenous corticosteroids

Hypothyroidism

Hypoadrenocorticism

Hypokalemic polymyopathy (cat)

- Increased urinary excretion
- Decreased dietary intake

Mitochondrial myopathies

Lipid storage myopathies

Glycogen storage disorders

Malignant hyperthermia

Hyperkalemic periodic paralysis (American Pit Bull Terrier)

### Inherited Myopathies

Muscular dystrophy

- Hereditary Golden Retriever muscular dystrophy
- Also German Shorthaired Pointer, Rottweiler, others
- Maine Coon, Siamese, Devon Rex, Sphynx, others

Myotonia—Chow Chow, Staffordshire Bull Terrier, Labrador Retriever, Rhodesian Ridgeback, Great Dane, others

Malignant hyperthermia

- Hypermetabolic disorder of skeletal muscle
- Genetic defect in intracellular calcium homeostasis

Inherited myopathy of Great Danes

Centronuclear myopathy—Labrador Retriever

Episodic/exercise-induced collapse—Labrador Retriever

Exertional rhabdomyolysis





# Neurologic Examination

## Components

### Mental State

Normal  
Depression  
Stupor  
Coma  
Agitation  
Delirium

### Posture

Normal, upright  
Head tilt  
Wide-based stance  
Recumbent  
Extensor posturing  
Opisthotonus  
Pleurothotonus

### Gait

Proprioceptive deficits  
Paresis  
Circling  
Ataxia  
Dysmetria  
Lameness

### Postural Reactions

Conscious proprioception  
Hopping  
Wheelbarrowing  
Hemiwalking  
Extensor postural thrust

### Muscle Tone

Atrophy  
Decreased muscle tone (lesions of lower motor neurons)  
Increased muscle tone (lesions of upper motor neurons)  
Schiff–Sherrington posture (increased muscle tone and hyperextension of thoracic limbs)

### Spinal Reflexes

Absent, depressed, normal, or exaggerated  
Thoracic limb withdrawal (sixth cervical [C6], C7, C8, first thoracic [T1])  
Biceps (C6–C8) and triceps (C7–T2) reflexes  
Patellar (fourth lumbar [L4], L5, L6)  
Pelvic limb withdrawal (L6, L7, first sacral [S1])  
Sciatic (L6, L7, S1)  
Cranial tibial (L6, L7)  
Perineal (S1, S2, S3, pudendal nerve)  
Bulbourethral (S1, S2, S3, pudendal nerve)  
Panniculus (response absent caudal to spinal cord lesion, used at T3–L3)  
Crossed extensor reflex (indicative of upper motor neuron [UMN] disease)  
Cutaneous trunci reflex

## **Sensation and Pain**

Superficial pain

Deep pain

Hyperesthesia

## **Urinary Tract Function**

## **Cranial Nerves**

# Paroxysmal Disorders Confused with Epileptic Seizures

## Differential Diagnosis

### **Syncope (reduced cerebral blood flow)**

Cardiac arrhythmias  
Hypotension

### **Episodic Weakness**

Hypoglycemia  
Low blood cortisol  
Electrolyte disturbances

### **Myasthenia Gravis**

### **Acute Vestibular “Attacks”**

### **Movement Disorders**

Episodic falling  
Scotty cramp  
Head bobbing  
Dyskinesias

### **Sleep Disorders**

Narcolepsy  
Cataplexy

### **Obsessive Compulsive Disorder**

# Peripheral Neuropathies

Clinical signs depend on the nerve affected and the severity of the lesion.

## Differential Diagnosis

### Focal Disease

#### Trauma

Mechanical blows  
Fractures  
Pressure  
Stretching  
Laceration  
Injection of agents into nerves

#### Peripheral Nerve Tumors

Schwannoma  
Neurofibroma  
Neurofibrosarcoma  
Lymphoma

#### Facial Nerve Paralysis

Otitis media  
Trauma  
Neoplasia  
Foreign body (e.g., grass awn)  
Nasopharyngeal polyp in cats  
Hypothyroidism  
Idiopathic

#### Trigeminal Nerve Paralysis

Bilateral, idiopathic disorder, often self-limiting  
Middle-aged to older dogs, rarely cats

#### Idiopathic Peripheral Vestibular Disease

#### Hyperchylomicronemia

Leads to xanthomas in skin  
May compress peripheral nerves

#### Ischemic Neuromyopathy

Caudal aortic thromboembolism

### Generalized Chronic Polyneuropathies

Idiopathic  
Metabolic disorders

- Diabetes mellitus
- Hypothyroidism

Paraneoplastic syndromes

- Insulinoma
- Other tumors

SLE or other immune-mediated disease  
Chronic organophosphate toxicity

Ehrlichiosis

### **Generalized Acute Neuropathies**

Acute polyradiculoneuritis (“coonhound paralysis”)

Neospora polyradiculoneuritis (puppies)

Disorders of neuromuscular junction

- Botulism
- Tick paralysis
- Myasthenia gravis

Protozoal polyradiculoneuritis

Dysautonomia

### **Developmental/Congenital Neuropathies**

Loss of motor neurons—Cairn Terrier, German Shepherd, English Pointer, Rottweiler, Swedish Lapland, Brittany Spaniel

Loss of peripheral axons—German Shepherd, Alaskan Malamute, Birman cat, Rottweiler, Boxer, Dalmatian

Schwann cell dysfunction—Golden Retriever, Tibetan Mastiff

Loss of sensory neuron of axon and laryngeal nerves—Dachshund, English Pointer, Shorthaired Pointer, Bouvier des Flandres, Siberian Husky

Inborn errors of metabolism

- Hyperchylomicronemia (cat)
- Hyperoxaluria type 2 (shorthaired cat)
- $\alpha$ -1-Fucosidosis (English Springer Spaniel)
- Atypical GM2 gangliosidosis (cat)
- Globoid cell leukodystrophy
- Niemann–Pick disease (Siamese)
- Glycogen storage disease (Norwegian Forest Cat)

# Spinal Cord Disease

## Differential Diagnosis

### Acute

Trauma  
Hemorrhage/coagulopathy  
Infarction  
Type I intervertebral disk herniation  
Fibrocartilaginous embolism  
Atlantoaxial subluxation

### Subacute/Progressive

Diskospondylitis  
Noninfectious inflammatory diseases

- Corticosteroid-responsive meningitis/arteritis
- Granulomatous meningoencephalitis
- Feline polioencephalomyelitis

Infectious inflammatory diseases

- Bacterial, fungal, rickettsial, protothecal, protozoal, nematodiasis

Distemper myelitis  
FIP meningitis/myelitis

### Chronic Progressive

Neoplasia  
Type II intervertebral disk protrusion  
Degenerative myelopathy  
Cauda equina syndrome  
Cervical vertebral malformation/malarticulation (wobbler syndrome)  
Lumbosacral vertebral canal stenosis  
Spondylosis deformans  
Hypervitaminosis A (cats)  
Dural ossification  
Diffuse idiopathic skeletal hyperostosis  
Synovial cyst

### Progressive in Young Animals

Neuronal abiotrophies and degenerations  
Metabolic storage diseases  
Atlantoaxial luxation  
Congenital vertebral anomalies

### Congenital (Constant)

Spinal bifida  
Congenital dysgenesis of Manx cats  
Spinal dysraphism  
Hereditary ataxia  
Pilonidal, epidermoid, and dermoid cysts  
Syringomyelia/hydromyelia

# Spinal Cord Lesions

## Localization

### Cranial Cervical Lesion (C1-C5)

UMN signs in rear limbs

UMN signs in forelimbs

### Caudal Cervical Lesion (C6-T2)

UMN signs in rear limbs

Lower motor neuron (LMN) signs in forelimbs

### Thoracolumbar Lesion (T3-L3)

UMN signs in rear limbs

Normal forelimbs

### Lumbosacral Lesion (L4-S3)

LMN signs in rear limbs

Loss of perineal sensation and reflexes

Normal forelimbs

### Sacral Lesion (S1-S3)

Normal forelimbs

Normal patellar reflexes

Loss of sciatic function

Loss of perineal sensation and reflexes



# **Systemic Disease**

## **Neurologic Manifestations**

### **Oxygen Deprivation**

#### **Vascular Disease**

##### **Ischemia**

Thromboembolic disease  
Shock  
Cardiac disease

##### **Hemorrhage (anemia)**

Vessel rupture secondary to hypertension  
Coagulopathy  
Vasculitis

### **Anesthetic Accidents (hypotension, cardiac arrhythmia, extensive blood loss, hypercapnia, hypoxemia)**

#### **Hypoxia**

Pulmonary disease  
Decreased oxygen transport  
Heart failure

#### **Hypertension**

#### **Hypoglycemia**

#### **Decreased Output or Metabolism**

Primary liver disease  
Malnutrition  
Thiamine deficiency

#### **Increased Uptake**

##### **Hyperinsulinemia**

Islet cell tumors  
Insulin overdose

##### **Non–Islet Cell Neoplasia**

Hepatoma  
Leiomyoma

##### **Excessive Metabolism**

Sepsis  
Breed or activity-related

### **Increased Uptake of Amino Acids by Extrahepatic Tissues**

### **Water and Ionic Imbalances**

#### **Water**

### **Hypoosmolar States (Retention of Free Water)**

Hyponatremia

### **Hyperosmolar States (Loss of Free Water)**

Hypernatremia (diabetes insipidus)

Hyperglycemia (diabetes mellitus)

### **Ions (Excess or Deficiency)**

Calcium

Potassium

## **Endogenous Neurotoxins**

### **Renal Toxins**

### **Hepatoencephalopathy**

### **Endocrine Disease**

#### **Adrenal**

Hyperadrenocorticism

Hypoadrenocorticism

#### **Adrenergic Dysregulation**

Pheochromocytoma

#### **Thyroid**

Hypothyroidism

- Myxedema
- Neuromyopathy

Thyrotoxicosis

- Hyperthyroidism
- Iatrogenic

## **Exogenous Neurotoxins**

Plant toxins

Sedative depressant drugs (e.g., antiepileptic drugs)

Heat stroke

## **Remote Neurologic Manifestations of Cancer**

Metastasis to the nervous system

Vascular accidents and infection

Adverse effects of therapy

Paraneoplastic syndromes

# Vestibular Disease

## Clinical Findings

### Central and Peripheral Vestibular Disease

Head tilt to side of lesion  
Circling/falling/rolling to side of lesion  
Vomiting, salivation  
Incoordination  
Ventral strabismus on side of lesion ( $\pm$ )  
Nystagmus, fast phase away from lesion  
Nystagmus may intensify with changes in body position.

### Peripheral Vestibular Disease

Nystagmus is horizontal or rotatory.  
No change in nystagmus direction with changes in head position  
Postural reactions and proprioception normal  
Concurrent Horner syndrome, CN VII paralysis with middle/inner ear involvement; other CNs normal

### Central Vestibular Disease

Nystagmus horizontal, rotatory, or vertical  
Nystagmus direction may change direction with change in head position.  
Abnormal postural reactions and proprioception may be seen on side of lesion.  
Multiple CN deficits may be seen.

### Paradoxical vestibular syndrome (cerebellar lesion)

Head tilt and circling away from side of lesion  
Fast-phase nystagmus toward the lesion  
May exhibit vertical nystagmus  
Abnormal postural reactions on side of lesion  
 $\pm$  Multiple cranial nerve deficits on side of lesion  
 $\pm$  Hypermetria, truncal sway, and head tremor

---

## SECTION XII

# Ocular Disorders

---

Anisocoria  
Blindness, Acute  
Corneal Color Changes  
Eyelids and Periocular Skin  
Nonhealing Corneal Erosions (Ulcers) in Dogs  
Ocular Manifestations of Systemic Diseases  
Ocular Neoplasia  
Red Eye  
Retinal Detachment  
Uveitis

# Anisocoria

## Differential Diagnosis

### Nonneurologic Causes of Anisocoria

#### Conditions That Cause Miosis

- Anterior uveitis
- Corneal ulcers and lacerations (reflex miosis mediated by trigeminal nerve)

#### Conditions That Cause Mydriasis

- Iris atrophy
- Iris coloboma
- Iris hypoplasia
- Glaucoma
- Iridal tumors (e.g., melanoma) that infiltrate iridal musculature
- Unilateral retinal disease (e.g., retinal detachment)
- Severe chorioretinitis that affects a larger area on one eye than the other
- Unilateral optic neuritis or optic nerve neoplasia
- Orbital neoplasia, retrobulbar abscess, cellulitis

### Pharmacologic Causes of Anisocoria

#### Drugs that Cause Miosis (usually agents used for management of glaucoma)

- Pilocarpine
- Demecarium bromide
- Synthetic prostaglandins such as latanoprost

#### Drugs that Cause Mydriasis

- Tropicamide, atropine
- Ocular contact with toxins like jimsonweed (*Datura stramonium*)
- Ocular decongestants like phenylephrine

### Neurologic Causes of Anisocoria

#### Afferent Lesions

Anisocoria is reduced or abolished in darkness as both pupils dilate. This is because the stimulus producing the anisocoria, light causing constriction of the normal pupil, is eliminated.

- Unilateral retinal or prechiasmal optic nerve lesion
- Unilateral optic tract lesion
- Optic chiasm lesion

#### Efferent Lesions

Parasympathetic efferent lesions. (In dogs, preganglionic efferent nerves are purely parasympathetic and postganglionic nerves are mixed. In cats both nerves are purely parasympathetic.)

- Lesions of the nucleus of CN III, the preganglionic fibers, or the ganglion itself

Sympathetic efferent lesions. (Loss of sympathetic tone to the eye is known as *Horner syndrome*; is always ipsilateral to the lesion; and features miosis, ptosis, protrusion of the third eyelid, and enophthalmos.)

- Head, neck, or chest trauma
- Brachial plexus avulsion
- Intracranial, mediastinal, or intrathoracic neoplasia
- Otitis media/interna
- Injury to the ear during ear flushing
- Idiopathic (Golden Retriever and Collie may be predisposed)



# Blindness, Acute

## Differential Diagnosis, Dogs and Cats

### Cornea

Edema (glaucoma, trauma, endothelial dystrophy, immune-mediated keratitis, neurotropic keratitis, anterior uveitis)  
Melanin (entropion, ectropion, lagophthalmos, facial nerve paralysis, keratoconjunctivitis sicca, pannus)  
Cellular infiltrate (bacterial, viral, fungal)  
Vascular invasion (exposure keratitis)  
Fibrosis (scar formation)  
Dystrophy (lipid, genetic)  
Symblepharon (conjunctiva adhered to cornea)

### Aqueous Humor

Fibrin (anterior uveitis: many etiologies)  
Hyphema (trauma, coagulopathies, neoplasia, systemic hypertension, retinal detachment)  
Hypopyon (immune-mediated, lymphoma, systemic fungal infection, toxoplasmosis, FIP, protothecosis, brucellosis, bacterial septicemia)  
Lipemic (hyperlipidemia with concurrent blood–aqueous barrier disruption [uveitis])

### Lens

Cataracts (genetic, diabetes, retinal degeneration, hypocalcemia, electric shock, chronic uveitis, lens luxation, metabolic, toxic, traumatic, nutritional)

### Vitreous

Hemorrhage (trauma, systemic hypertension, retinal detachment, neoplasia, coagulopathy)  
Hyalitis (numerous infectious agents, penetrating injury)

### Retina

Retinopathy (glaucoma, sudden acquired retinal degeneration [SARD], progressive retinal atrophy, central progressive retinal atrophy, feline central retinal atrophy, toxicity, taurine deficiency in cats, vitamin E deficiency in dogs, enrofloxacin toxicity in cats)  
Chorioretinitis (systemic mycoses, ehrlichiosis, Rocky Mountain spotted fever, canine distemper, toxoplasmosis, FIP, protothecosis, brucellosis, bacterial septicemia, intraocular larval migrans, neoplasia)  
Retinal detachment (neoplasia, retinal dysplasia, hereditary/congenital, exudative/transudative disorders such as systemic hypertension or infection-induced inflammatory disease)

### Lesions that Prevent Transmission of the Image (optic nerve disease)

Viruses (canine distemper, FIP)  
Systemic diseases (neoplasia, traumatic avulsion of optic nerve, granulomatous meningoencephalitis, hydrocephalus, optic nerve hypoplasia, immune-mediated optic neuritis, systemic mycoses)

### Lesions that Prevent Interpretation of the Visual Message

Canine distemper, FIP, toxoplasmosis, granulomatous meningoencephalitis, systemic mycoses, trauma, heat stroke, hypoxia, hydrocephalus, hepatoencephalopathy, neoplasia, storage diseases, postictal, meningitis





# Corneal Color Changes

## Diagnostic Tests

### Red (blood vessels)

- Mechanism is chronic irritation
- Fluorescein stain, Schirmer tear test (STT), palpebral and corneal reflexes

### “Fluffy” Blue (stromal edema)

- Mechanisms are endothelial or epithelial dysfunction
- Fluorescein stain, intraocular pressure (IOP), flare, check for lens luxation

### “Wispy” Gray (stromal scar)

- Mechanism is previous (inactive) inflammation
- Fluorescein stain

### “Sparkly” White (lipid/mineral accumulation)

- Mechanisms are dystrophy, degeneration, or hyperlipidemia
- Fluorescein stain, systemic lipid analysis

### Black (pigmentation)

- Mechanism is chronic irritation
- Fluorescein stain, STT

### “Punctate” Tan (keratinic precipitates or staphyloma)

- Mechanism is uveitis
- IOP, flare, systemic disease testing

### Yellow-Green (inflammatory cell infiltration)

- Inflammation (usually septic)
- Fluorescein stain, cytology, culture and sensitivity testing, PCR

# Eyelids and Periocular Skin

## Differential Diagnosis

### Infectious Blepharitis

#### Bacterial Blepharitis

- Usually *Staphylococcus* spp.
- External hordeolum or styne—infection of the glands of Zeis or Moll
- Internal hordeolum—infection of the meibomian glands
- Chalazion—meibomian secretions thicken and obstruct the duct, leading to glandular rupture and lipogranuloma formation

#### Fungal Blepharitis

- Dermatophytes (*Microsporum canis*, *Microsporum gypseum*, *Trichophyton mentagrophytes*)
- *Malassezia pachydermatitis*—most dogs with *Malassezia* dermatitis have concurrent dermatoses; in cats *Malassezia* infection is linked to systemic disease like diabetes, retroviral infection, internal neoplasia

#### Parasitic Blepharitis

- Demodicosis
- Feline herpetic ulcerative dermatitis

#### Allergic Blepharitis

- Atopic dermatitis
- Cutaneous adverse food reaction (food allergy)

#### Metabolic/Nutritional Blepharitis

- Zinc-responsive dermatosis
- Superficial necrolytic dermatitis (hepatocutaneous disease)

#### Immune-Mediated Blepharitis

- Pemphigus foliaceus
- Pemphigus erythematosus
- SLE
- Erythema multiforme

#### Iatrogenic Blepharitis (adverse reactions to topical medications)

#### Pigmentary Changes Involving the Eyelid

- Lentigo simplex of orange cats (black macules, not pathogenic)
- Vitiligo (hypopigmentation)
- Uveodermatologic (Vogt–Koyanagi–Harada-like) syndrome (leukoderma)

#### Neoplastic Blepharitis

- Meibomian gland adenoma
- Papillomas
- Squamous cell carcinoma
- Lymphosarcoma
- MCT

#### Miscellaneous Eyelid Diseases

- Juvenile sterile granulomatous dermatitis and lymphadenitis/juvenile cellulitis (puppy strangles)
- Canine reactive histiocytosis

- Entropion
- Ectropion
- Distichiasis
- Trichiasis

# Nonhealing Corneal Erosions (Ulcers) in Dogs

## Causes

Establish underlying cause of impaired wound healing.

- Mechanical trauma from lid masses
- Entropion, ectropion
- Foreign bodies
- Secondary infection
- Corneal exposure caused by lid paralysis
- Exophthalmos
- Buphthalmos
- Tear film abnormalities
- Conformational abnormalities resulting in lagophthalmos
- Corneal edema
- Distichiasis, ectopic cilia
- Facial fold irritation of cornea

## **Spontaneous Chronic Corneal Epithelial Defects (SCCEDs)—also called *indolent erosions/ulcers* or *Boxer erosions/ulcers***

- Middle-aged dogs
- Boxers predisposed
- Likely instigated by superficial trauma
- Dogs with diabetes mellitus predisposed
- Rim of loose epithelium surrounds corneal defect
- No loss of stromal substance (stromal loss indicates more severe process, typically infection)
- Blepharospasm/epiphora
- Neovascularization may be delayed compared with healing corneal ulcers.

## **Bullous Keratopathy**

# Ocular Manifestations of Systemic Diseases

## Surface Ocular Disease

### Eyelids

Immunosuppressive disorders may predispose to Meibomian gland infection with *Demodex* or *Staphylococcus* spp.

Eyelids have mucocutaneous junction; affected by autoimmune disorders such as SLE and pemphigoid diseases; also may be affected by uveodermatologic syndrome and vasculitis

Altered lid position, CN III or VII dysfunction

Horner syndrome: decreased sympathetic tone causing enophthalmos with third eyelid protrusion, ptosis, and miosis; often idiopathic; may be seen with disease of brain, spinal cord, brachial plexus, thorax, mediastinum, neck, temporal bone, tympanic bulla, or orbit

### Conjunctivitis

May reflect disease of deeper ocular structures

Good location to detect pallor, cyanosis, icterus

Feline herpesvirus type 1 (FHV-1) and *Chlamydomphila felis* are primary pathogens of the conjunctiva.

### Cornea/Sclera

Creamy pink discoloration of cornea may be seen with lymphoma.

Corneal lipidosis appears similar; it may be secondary to hyperlipidemia from hypothyroidism, hyperadrenocorticism, diabetes mellitus, and familial hypertriglyceridemia.

### Keratoconjunctivitis Sicca

Most cases are caused by lymphoplasmacytic dacryoadenitis.

Rarely seen with xerostomia (Sjögren-like syndrome)

Possible causes include drug therapy, atropine, sulfa drugs, etodolac, and anesthetic agents.

Others causes include canine distemper, FHV-1, and dysautonomia.

## Uveal Tract, Lens, Fundus

### Uveal Tract

#### Hyphema or Hemorrhage

Hypertension, rickettsial disease, trauma, coagulopathy, lymphoma, metastatic neoplasia

#### Protein or Fibrin Deposition

Trauma, FIP, uveodermatologic syndrome, lens capsule rupture, rickettsial disease

#### Cellular (Hypopyon) or Granulomatous Infiltrates

Trauma, lymphoma, metastatic neoplasia, uveodermatologic syndrome, algae or yeast, lens capsule rupture, FIP, systemic mycoses, toxoplasmosis

Other infectious agents associated with uveal tract disease include FIV, FeLV, mycobacteria, FHV-1, *Bartonella* spp., *Ehrlichia* spp., *Leishmania donovani*, *Rickettsia rickettsii*, *Brucella canis*, *Leptospira* spp., and canine adenovirus.

#### Iris Abnormalities (Papillary Changes)

Anisocoria with FeLV

Miosis with Horner syndrome

Mydriasis with dysautonomia

### Lens

### **Cataracts**

Most common cause in dogs is hereditary.

Cataracts are frequent complication of diabetes mellitus.

Uveitis may also cause cataracts (most common cause in cats).

Other causes include hypocalcemia (hypoparathyroidism), electric shock, lightning strike, altered nutrition (e.g., puppies fed milk replacer).

### **Lens Luxation/Subluxation**

Most often secondary to severe intraocular disease (uveitis)

May be primary in terriers

### **Fundus**

Usually affected by diseases that extend from the uveal tract (see previous section) or from CNS (immune-mediated diseases such as granulomatous meningoencephalitis or neoplasia of CNS)

### **Papilledema**

Optic nerve edema without hemorrhage, exudates, or blindness

Seen with increased intracranial pressure

### **Taurine Deficiency**

Retinal degeneration

May also cause dilated cardiomyopathy

### **Retinal Visualization**

Allows assessment of systemic condition, including anemia (attenuated, pale vessels), hyperlipidemia (creamy orange hue to vessels), and hyperviscosity (increased vessel tortuosity)

### **Systemic Hypertension**

Causes extravasation of blood into retina, choroid, or subretinal space

## Ocular Neoplasia

### Orbital Neoplasia (presents as exophthalmos, strabismus, protrusion of the third eyelid, epiphora, and exposure keratitis)

- Osteosarcoma
- Multilobular osteosarcoma
- Fibrosarcoma
- Invasion of orbit by neoplasms of surrounding structures such as nose, sinuses, oral cavity, and orbital glands (nasal adenocarcinoma most commonly)
- Cats are more likely to have invasion of orbit from surrounding structures (fibrosarcoma, undifferentiated sarcoma, adenocarcinoma, lymphoma). Rarely see primary orbital neoplasia (squamous cell carcinoma, melanoma).

### Adnexal Neoplasia (eyelid neoplasia common in dogs and rare in cats)

- Ninety percent of eyelid tumors are benign (Meibomian adenomas, melanomas, papillomas most commonly).
- Less common adnexal tumors include histiocytoma, malignant melanoma, adenocarcinoma, basal cell carcinoma, MCT, squamous cell carcinoma, hemangiosarcoma.
- Squamous cell carcinoma is the most common eyelid tumor in cats. Associated with sun exposure in cats that lack periocular pigmentation.

### Surface Ocular Neoplasia (tumors of the conjunctiva, third eyelid, cornea)

- Dermoid
- Epibulbar or limbal melanocytoma
- Conjunctival neoplasia: hemangioma, hemangiosarcoma, MCT, lymphoma, squamous cell carcinoma, papilloma
- Third eyelid neoplasia: adenocarcinoma (most common), hemangiosarcoma, lobular adenoma, squamous cell carcinoma, melanoma

### Intraocular Neoplasia (present with glaucoma, hyphema, corneal edema, buphthalmos, dyscoria, uveitis, retinal detachment, blindness)

- Anterior uveal melanoma (most common), 82% are benign in dogs, poorer prognosis in cats
- Other primary tumors of dogs include ciliary body adenocarcinoma and medulloepithelioma.
- Other primary tumors of cats include posttraumatic sarcoma and lymphoma.

# Red Eye

## Differential Diagnosis

### Erythema of Primarily Conjunctival Vessels

- Corneal ulceration
- Eyelid abnormalities
- Dacryocystitis
- Cilia abnormalities
- Keratoconjunctivitis sicca
- Allergic conjunctivitis
- Bacterial or fungal keratitis
- Orbital disease

### Erythema of Primarily Episcleral Vessels

- Anterior uveitis (low IOP)
- Glaucoma (high IOP)

### Focal Erythema

#### Masses

- Prolapse of the gland of the third eyelid
- Neoplasia
- Episcleritis
- Nodular granulomatous episcleritis
- Granulation tissue

#### Hemorrhage

- Trauma
- Systemic disease (vasculitis, coagulopathy)



# Retinal Detachment

## Differential Diagnosis

### Three Main Mechanisms—exudative, associated with retinal tears (rhegmatogenous), or traction pulling on retina

- Trauma—penetrating injuries such as animal bites, projectiles, or foreign bodies may result in retinal tears or induce intraocular hemorrhage, inflammation, or vitreous infection with subsequent traction retinal detachment. Typically unilateral, although strangulation can lead to bilateral retinal detachment.
- Ocular anomalies such as severe retinal dysplasia, optic nerve colobomas, vitreous abnormalities, and retinal nonattachment (developmental failure of the two retinal layers to unite)
- Later-onset ocular anomalies such as cataracts and vitreous degeneration may lead to rhegmatogenous retinal detachment, especially with rapid-forming or hypermature cataracts that lead to lens-induced uveitis.
- Hypertension is most often related to renal disease but may also be seen with hyperthyroidism and pheochromocytoma.
- Hyperviscosity—severe hyperlipidemia, hyperglobulinemia, polycythemia
- Neoplasia—most commonly due to multiple myeloma (hyperproteinemia and hyperviscosity) and lymphoma (infiltration of retina and choroid). Large intraocular tumors may induce traction retinal detachment.
- Chorioretinitis, retinochoroiditis
- Bacteria (leptospirosis, brucellosis, bartonellosis)
- Rickettsia (ehrlichiosis, Rocky Mountain spotted fever)
- Fungal (aspergillosis, blastomycosis, coccidioidomycosis, histoplasmosis, cryptococcosis)
  - Algae (geotrichosis, protothecosis)
  - Viral (canine distemper virus, FIP)
  - Secondary to retroviral infection (FeLV, FIV by predisposing to lymphosarcoma or an opportunistic infection like toxoplasmosis)
  - Parasitic (causes smaller areas of detachment—larval migrans of strongyles, ascarids, or *Baylisascaris* larvae, toxoplasmosis, leishmaniasis, neospora, babesiosis.)
- Immune-mediated disease—causes vasculitis with or without chorioretinitis
  - SLE
  - Uveodermatologic syndrome
  - Granulomatous meningoencephalitis
- Toxic—trimethoprim/sulfa or ethylene glycol in dogs, griseofulvin in cats
- Idiopathic

# Uveitis

## Differential Diagnosis in the Dog and Cat

### Systemic Infection

#### Bacterial

- Bacteremia or septicemia (d, c)
- Bartonellosis (d, c)
- Leptospirosis (d)
- Borreliosis (d)
- Brucellosis (d)

#### Rickettsial

- Ehrlichiosis (d, c)
- Rocky Mountain spotted fever (d)

#### Viral

- Canine adenovirus-1 (d)
- FeLV (c)
- FIV (c)
- FIP (c)

#### Mycotic

- Blastomycosis (d, c)
- Histoplasmosis (d, c)
- Coccidiomycosis (d, c)
- Cryptomycosis (d, c)
- Aspergillosis (d)

#### Algal

- Protothecosis

#### Parasitic

- Aberrant nematode larval migration
- *Toxocara* (ocular larval migrans) (d, c)
- *Dirofilaria* larvae (d)

#### Protozoan

- Toxoplasmosis (d, c)
- Leishmaniasis (d, c)

#### Immune-Mediated Uveitis

- Idiopathic anterior uveitis (d, c)
- Lens-induced uveitis (d, c)
- Canine adenovirus vaccine reaction (d)
- Uveodermatologic syndrome (d) (primarily Akita and Arctic breeds)
- Pigmentary uveitis (d) (primarily Golden Retrievers)

#### Neoplasia

- Primary (d, c)
- Metastatic (most commonly lymphoma) (d, c)

#### Metabolic

- Diabetes mellitus (lens-induced uveitis) (d)
- Hyperlipidemia (d)

### **Trauma**

- Blunt or sharp (d, c)

### **Miscellaneous Causes of Blood/Eye Barrier Disruption**

- Hyperviscosity syndrome (d, c)
- Hypertension (d, c)
- Scleritis (d)
- Ulcerative keratitis (d, c)

---

## **SECTION XIII**

# Toxicology

---

Chemical Toxicoses

Plant Toxicoses

Venomous Bites and Stings

# Chemical Toxicoses

## Toxicants

### **Kerosene, Gasoline, Mineral Seal Oil, Turpentine, Others**

Pulmonary, CNS, and GI signs: may lead to hepatotoxicity, renal toxicity, and cardiac arrhythmias

### **Naphthalene (Mothballs)**

Vomiting, lethargy, seizures, acute Heinz body hemolytic anemia, methemoglobinemia, hemoglobinuria, renal failure

### **Ethanol, Methanol (Wood Alcohol)**

CNS depression, behavioral changes, ataxia, hypothermia, respiratory and cardiac arrest

### **Ethylene Glycol**

Early intoxication: ataxia, progresses to oliguric renal failure with renomegaly, vomiting, hypothermia, coma, and death

### **Soaps and Detergents**

GI irritants

### **Household Corrosives**

Toilet bowl cleansers, calcium/lime/rust removers, drain cleaners, oven cleaners, bleaches

### **Propylene Glycol**

Ataxia, CNS depression

### **Phenol Products (Household Cleaners)**

Cats particularly sensitive; hepatic and renal damage, ataxia, weakness, tremors, coma, seizures, respiratory alkalosis

### **Anticoagulant Rodenticides**

Petechiae, ecchymosis, weakness, pallor, respiratory distress, CNS depression, hematemesis, epistaxis, melena, ataxia, paresis, seizures, sudden death

### **Zinc Phosphate**

Anorexia, lethargy, weakness, abdominal pain, vomiting early after ingestion, progresses to recumbency, tremors, seizures, cardiopulmonary collapse, death

### **Cholecalciferol (Vitamin D) Rodenticides and Medications**

Anorexia, CNS depression, vomiting, muscle weakness, constipation, bloody diarrhea, polyuria/polydipsia

### **Bromethalin Rodenticides**

High-dose exposure: muscle tremors, hyperexcitability, vocalization, seizures, hyperesthesia, vomiting, dyspnea

### **Pyrethrin and Pyrethroid Insecticides**

CNS depression, hypersalivation, muscle tremors, vomiting, ataxia, dyspnea, anorexia, hypothermia, hyperthermia, seizures, rarely death

### **Organophosphate and Carbamate Insecticides**

Muscarinic signs (salivation, lacrimation, bronchial secretion, vomiting, diarrhea) and nicotinic signs (muscle tremors, respiratory paralysis), mixed signs (CNS depression, seizures, miosis, hyperactivity)

### **2,4-Dichlorophenoxyacetic Acid**

Vomiting, diarrhea; greater exposure may cause CNS depression, ataxia, and hindlimb myotonia.

### **Lead (Paints, Batteries, Linoleum, Solder, Plumbing Supplies, Fishing Weights)**

High-level exposure: vomiting, abdominal pain, anorexia, diarrhea, megaesophagus

CNS signs, behavioral changes, hysteria, ataxia, tremors, opisthotonos, blindness, seizures

### **Zinc**

Acute ingestion: vomiting, CNS depression, lethargy, diarrhea

Chronic exposure: anorexia, vomiting, diarrhea, CNS depression, pica, hemolysis, regenerative anemia, spherocytosis, inflammatory leukogram, icterus, renal failure

### **Iron**

Vomiting, diarrhea, abdominal pain, hematemesis, melena; rarely, progresses to multisystemic failure

## Plant Toxicoses

### Plants That Cause Hemolysis

Onion

### Plants that Affect the Cardiovascular System

Cardiac glycoside toxicity: bradycardia with first-, second-, or third-degree AV block, ventricular arrhythmias, asystole, and sudden death; also see GI signs

Common oleander (*Nerium oleander*)

Yellow oleander (*Thevetia peruviana*)

Foxglove (*Digitalis purpurea*)

Lily of the valley (*Convallaria majalis*)

Kalanchoe (*Bryophyllum* spp.)

Azalea (*Rhododendron* spp.): weakness, hypotension, dyspnea, respiratory failure, GI signs

Yew (*Taxus* spp.): conduction disturbances, bradycardia, GI signs, weakness, seizures; poor prognosis once signs are seen

### Plants Affecting the Gastrointestinal System

Oxalate-containing plants: gastric and ocular irritants

Dumbcane (*Dieffenbachia* spp.)

Philodendron (*Philodendron* spp.)

Peace lily (*Spathiphyllum* spp.)

Devil's ivy (*Epipremnum aureum*)

Rhubarb leaves (*Rheum* spp.)

Philodendron may cause renal and CNS signs in cats.

Chinaberry tree (*Melia azedarach*): vomiting, diarrhea, abdominal pain, hypersalivation, may progress to CNS signs and death

Cycad palms (*Cycas* spp.) or sago palms (*Macrozamia* spp.): vomiting, diarrhea, followed by lethargy, depression, liver failure, and death (dogs)

English ivy (*Hedera helix*): GI irritation, profuse salivation, abdominal pain, vomiting, diarrhea

Castor bean plant (*Ricinus communis*): ricin is among the most deadly poisons in the world; severe abdominal pain, vomiting, diarrhea, seizures, cerebral edema; prognosis for recovery is poor once clinical signs develop.

Holly (*Ilex* spp.), poinsettia (*Euphorbia pulcherrima*), mistletoe (*Phoradendron flavescens*): mild GI irritation, occasionally diarrhea, more serious effects with mistletoe

Amaryllis, jonquil, daffodil (family Amaryllidaceae), tulip (family Liliaceae), iris (family Iridaceae): ingestion of bulb associated with mild-to-moderate gastroenteritis

Autumn crocus (*Colchicum autumnale*), glory lily (*Gloriosa* spp.): colchicine, vomiting, diarrhea, abdominal pain, hypersalivation progressing to depression, multiple organ system collapse and death

Solanaceae family: tomato, eggplant, deadly or black nightshade, Jerusalem cherry-solanine, gastric irritant; may cause CNS depression and cardiac arrhythmias; nightshade can also contain belladonna.

Mushrooms: amanitine poisoning (*Amanita virosa*, *Amanita phalloides*, *Conocybe filaris*), orellanine poisoning (*Cortinarius orellanus*, *Cortinarius rainierensis*), monomethylhydrazine (*Gyromitra esculenta*)—severe hepatic disease; survivors of hepatic phase may succumb to renal tubular necrosis.

### Plants Affecting the Neurologic System

Tobacco (*Nicotiana tabacum*): vomiting, CNS involvement, cardiac involvement

Hallucinogenic plants: psilocybins or “magic mushrooms,” marijuana (*Cannabis sativa*), jimsonweed (*Datura stramonium*), thorn apple (*Datura meteliodyl*), blue morning glory (*Ipomoea violacea*), nutmeg (*Myristica fragrans*), peyote (family Cactaceae)

Nettle toxicity (family Urticaceae): hunting dogs, toxins contained in needles (histamine, acetylcholine, serotonin, formic acid), salivation, vomiting, pawing at mouth, tremors, dyspnea, slow and irregular heartbeat

Macadamia nuts: locomotor disturbances, tremors, ataxia, weakness

Yesterday, today, tomorrow (*Brunfelsia* spp.)

## Plants Affecting the Renal System

Easter lily (*Lilium longiflorum*) and daylily (*Heemerocallis* spp.), possibly other lilies: toxic to cats, vomiting, depression, anorexia, leading to acute renal failure, poor prognosis without early treatment

Raisins/grapes: acute renal failure

## Plants Causing Sudden Death

Seeds of many fruit trees (apple, apricot, cherry, peach, plum), contain cyanogenic glycosides.



## Venomous Bites and Stings

### Snakes, Spiders, Others

#### **Crotalids (Pit Vipers, Rattlesnakes, Copperheads, Water Moccasins)**

Enzymatic and nonenzymatic proteins, local tissue damage: localized pain, salivation, weakness, fasciculations, hypotension, alterations in respiratory pattern, regional lymphadenopathy, mucosal bleeding, obtundation, convulsions, anemia, echinocytosis, stress leukogram

#### **Elapids (Coral Snakes)**

Rare envenomation, signs delayed 10-18 hours, emesis, salivation, agitation, central depression, quadriplegia, hyporeflexia, intravascular hemolysis, respiratory paralysis

#### ***Latrodectus* spp. (Widow Spiders)**

Hyperesthesia, muscle fasciculations, cramping, somatic abdominal pain (characteristic sign), respiratory compromise, hypertension, tachycardia, seizures, agitation, ataxia, cardiopulmonary collapse

#### **Loxoscelidae (Recluse or Brown Spiders)**

Cutaneous form: bull's-eye lesion, pale center with localized thrombosis, surrounded by erythema, develops into a hemorrhagic bulla with underlying eschar  
Viscerocutaneous form: Coombs-negative hemolytic anemia, thrombocytopenia, DIC

#### **Tick Paralysis**

*Dermacentor* and *Haemaphysalis* ticks, ascending paralysis, lower motor neuron signs, megaesophagus and aspiration pneumonia in severe cases, spontaneous recovery a few days after tick removal

#### **Hymenopteran Stings**

Bites and stings of winged insects and fire ants  
Toxic and allergic reactions (localized angioedema, urticaria, emesis, diarrhea, hematochezia, respiratory depression, death)

#### **Helodermatidae Lizard (Gila Monster)**

Salivation, lacrimation, emesis, tachypnea, respiratory distress, tachycardia, hypotension, shock

---

## SECTION XIV

# Urogenital Disorders

---

Differentiating between Urine Marking and Inappropriate Elimination in Cats  
Glomerular Disease  
Indications for Cytoscopy  
Mammary Masses  
Prostatic Disease  
Proteinuria in Dogs and Cats  
Pyelonephritis, Bacterial  
Renal Disease  
Reproductive Disorders  
Ureteral Diseases  
Urinary Tract Infection (UTI)  
Uroliths, Canine  
Vaginal Discharge

# Differentiating between Urine Marking and Inappropriate Elimination in Cats

## Urine Marking

- Generally vertical surfaces (can be horizontal)
- Marking behavior (may be territorial signaling or an anxiety- or conflict-induced response)
- Most common in intact males, females in estrous
- Adults
- Urine (rarely stool)
- Doors, windows, new objects, owner's possessions, frequently used furniture

## Inappropriate Elimination

- Horizontal surfaces (rarely vertical)
- Elimination behavior
- Males or females, intact or neutered
- Any age
- Urine and/or stool
- Elimination in a variety of areas

## Glomerular Disease

### Types, Dogs and Cats

Glomerulonephritis

Membranoproliferative form

- Type I (mesangiocapillary)
- Type II (dense deposit disease)

Proliferative glomerulonephritis (mesangial and endocapillary)

Crescentic type (rare)

Amyloidosis

Glomerulosclerosis

Focal segmental glomerulosclerosis

Hereditary nephritis

Immunoglobulin A (IgA) nephropathy

Lupus nephritis

Membranous glomerulopathy (most common in cats)

Minimal change glomerulopathy

### Differential Diagnosis for Diseases Associated with Glomerular Disease, Dogs

#### Infection

##### Bacterial

Pyelonephritis

Pyoderma

Pyometra

Endocarditis

Bartonellosis

Brucellosis

Borreliosis

Other chronic bacterial infections

##### Parasitic

Dirofilariasis

##### Rickettsial

Ehrlichiosis

##### Fungal

Blastomycosis

Coccidioidomycosis

##### Protozoal

Babesiosis

Hepatozoonosis

Leishmaniasis

Trypanosomiasis

##### Viral

Canine adenovirus (type I) infection

#### Inflammation

Periodontal disease  
Chronic dermatitis  
Pancreatitis  
Inflammatory bowel disease  
Polyarthritits  
SLE  
Other immune-mediated diseases

### **Neoplasia**

Lymphosarcoma  
Mastocytosis  
Leukemia  
Systemic histiocytosis  
Primary erythrocytosis  
Other neoplasms

### **Miscellaneous**

Corticosteroid excess  
Trimethoprim-sulfa therapy  
Hyperlipidemia  
Chronic insulin infusion  
Congenital C3 deficiency  
Cyclic hematopoiesis in gray Collies

### **Familial**

Amyloidosis (Beagle, English Foxhound)  
Hereditary nephritis (Bull Terrier, English Cocker Spaniel, Dalmatian, Samoyed)  
Glomerulosclerosis (Doberman Pinscher, Newfoundland)  
Glomerular vasculopathy and necrosis (Greyhound)  
Mesangiocapillary glomerulonephritis (Bernese Mountain Dog)  
Atrophic glomerulopathy (Rottweiler)  
Proliferative and sclerosing glomerulonephritis (Soft-Coated Wheaten Terrier)

### **Idiopathic**

## **Differential Diagnosis for Diseases Associated with Glomerular Disease, Cats**

### **Infection**

#### **Bacterial**

Pyelonephritis  
Chronic bacterial infections  
Mycoplasmal polyarthritits

#### **Viral**

FIV  
FIP  
FeLV

### **Inflammation**

Pancreatitis  
Cholangiohepatitis  
Chronic progressive polyarthritits  
SLE

Other immune-mediated diseases

**Neoplasia**

Lymphosarcoma  
Leukemia  
Mastocytosis  
Other neoplasms

**Miscellaneous**

Acromegaly  
Mercury toxicity

**Familial**

**Idiopathic**

## Indications for Cystoscopy

- Localization of source of hematuria
- Urinary tract neoplasia
  - Determine extent and location of tumors.
  - Obtain samples for cytology or histopathology.
- Recurrent urinary tract infections
  - Examine for anatomic abnormalities or uroliths.
  - Obtain samples for cytology, histopathology, or culture.
- Urinary tract trauma
  - Examine for perforations, ruptures, and patency of urinary tract.
- Urinary incontinence
  - Examine for ectopic ureters and/or urethral anomalies.
  - Laser ablation of intramural ectopic ureters
  - Periurethral collagen injections for treatment of refractory urethral incompetence
- Urolithiasis
  - Confirm and remove small uroliths from bladder or urethra.
  - Obtain uroliths for quantitative analysis and culture.
  - Retrieve uroliths from bladder or urethra using stone forceps or stone basket.
  - Fragment uroliths with laser lithotripsy.
  - Fill bladder before and after voiding urohydropropulsion to remove small uroliths.

# Mammary Masses

## Differential Diagnosis

- Benign mammary tumors
  - Mixed tumors (fibroadenomas)
  - Adenomas
  - Mesenchymal tumors
- Malignant mammary tumors
  - Solid carcinomas
  - Tubular adenocarcinomas
  - Papillary adenocarcinomas
  - Anaplastic carcinomas
  - Sarcomas (rare)
  - Most feline mammary tumors are adenocarcinomas
- Mammary hyperplasia
- Mastitis
- Granulomas
- Duct ectasia
- Skin tumors
- Lipomas
- Foreign bodies (e.g., BB pellets or shot may be confused with small mammary masses)



## Prostatic Disease

### Differential Diagnosis

Benign prostatic hyperplasia (BPH)

Acute prostatitis

Chronic prostatitis

Abscess

Cyst

Prostatic neoplasia

- Adenocarcinoma most common
- Transitional cell carcinoma second most common
- Urothelial carcinoma
- Primary and metastatic hemangiosarcoma
- Lymphoma

### Diagnostic Evaluation

- History of lower urinary tract signs, penile discharge, hematuria, dysuria, tenesmus, obstipation, ribbon stools, stiff gait. Severe systemic signs suggest sepsis or systemic inflammation raises suspicion of acute prostatitis. Intact males are more predisposed to BPH and prostatitis.
- Digital rectal examination along with caudal abdominal palpation is a noninvasive initial screening test. The prostate should be bilaterally symmetric, have a smooth and regular surface, have soft parenchyma, and not be painful to touch.
- Radiography of limited value for providing an actual diagnosis but may provide information about size, shape, contour, and location of the prostate. Prostatomegaly may cause dorsal displacement of the colon and cranial displacement of the urinary bladder. Mineralization with neoplasia, bacterial prostatitis, and abscessation may be apparent.
- Prostatic ultrasound is the most useful and practical imaging method. Normal prostate should have smooth borders and homogenous parenchymal pattern of moderate echogenicity. Ultrasound also offers the opportunity for guided aspirates and core biopsy sampling for culture, cytology, and histopathology.
- CT and MRI can evaluate size, shape, and homogeneity of prostate and allow evaluation of intrapelvic lesions, metastatic spread, and ureteral obstruction.
- Definitive diagnosis requires cytologic, histologic, or bacteriologic evaluation of a prostate sample. Samples can be obtained using procedures such as semen collection, prostatic massage and wash, brush technique, fine needle aspiration, and biopsy.

## Proteinuria in Dogs and Cats

### Diagnostic Approach

- Stop use of nephrotoxic drugs.
- If proteinuria is insignificant (trace to 1 + dipstick reading and urine specific gravity > 1.035), there is no need for further workup.
- Perform urinalysis to exclude hemorrhage, infection, or inflammation as cause of proteinuria. If these conditions are present, do urine culture. If these conditions are not present, do urine protein/creatinine ratio.
- Perform serum chemistry and CBC. Evaluate serum albumin and globulin.
- Marked proteinuria ratio (UP/UC > 3) with quiet sediment and normal globulins or a polyclonal gammopathy is consistent with renal glomerular disease (glomerulonephritis, amyloidosis). Rule out causes of glomerulonephropathy such as heartworm disease, hepatozoonosis, immune-mediated diseases such as SLE, chronic infectious diseases such as borreliosis, FeLV, FIV, ehrlichiosis, other chronic inflammatory diseases, neoplasia, and hyperadrenocorticism.
- If no underlying disease found, may need renal biopsy to assess for glomerulonephritis or amyloidosis
- Proteinuria detected by precipitation testing but not dipstick or proteinuria associated with a monoclonal gammopathy may be caused by Bence Jones proteins. This requires a search for osteolytic or lymphoproliferative lesions. Ehrlichiosis may mimic myeloma. If Ehrlichia negative, protein electrophoresis is indicated. A monoclonal gammopathy suggests myeloma.

## **Pyelonephritis, Bacterial**

### **Clinical Findings, Dogs and Cats**

Fever

Renal pain

Leukocytosis

Anorexia

Lethargy

Cellular casts in urine sediment

Azotemia

Hematuria

Inability to concentrate urine

Polyuria/polydipsia

Recurrent lower urinary tract infection

Ultrasonographic or excretory urographic abnormalities

- Renal pelvis dilatation
- Asymmetric filling of diverticula
- Dilated ureters

Bacteria in inflammatory lesions on histopathologic examination

Positive culture of ureteral urine collected by cystoscopy

Positive culture of urine obtained after rinsing bladder with sterile saline

Positive culture of urine obtained by ultrasound-guided pyelocentesis

## Renal Disease (see also Glomerular Disease)

### Familial—Dogs And Cats

Amyloidosis—Beagle, English Foxhound, Shar-Pei, Abyssinian cat, Oriental shorthaired cat, Siamese cat

Renal Dysplasia—Lhasa Apso, Shih Tzu, Standard Poodle, Soft Coated Wheaten Terrier, Chow Chow, Alaskan Malamute, Miniature Schnauzer, Dutch Kooiker (Dutch decoy dog)

Fanconi syndrome (tubular dysfunction)—Basenji

Tubular dysfunction (renal glucosuria)—Norwegian Elkhound

Basement membrane disorder—Bull Terrier, Doberman Pinscher, English Cocker Spaniel, Samoyed

Membranoproliferative glomerulonephritis—Bernese Mountain Dog, Brittany, Soft-Coated Wheaten Terrier

Primary glomerular disease—Rottweiler, Beagle, Pembroke Welsh Corgi, Newfoundland, Bullmastiff, Doberman Pinscher, Dalmatian, Bull Terrier, English Cocker Spaniel, Samoyed

Periglomerular fibrosis—Norwegian Elkhound

Polycystic kidney disease—Cairn Terrier, West Highland White Terrier, Bull Terrier, Persian cat

Multifocal cystadenocarcinoma—German Shepherd

### Differential Diagnosis, Renal Tubular Disease

#### Cystinuria

Inherited proximal tubular defect

Many breeds of dogs, including mixed breeds

Often leads to cystine calculi formation

#### Carnitinuria

Reported in dogs with cystinuria

May lead to carnitine deficiency and cardiomyopathy

#### Hyperuricosuria

Abnormal purine metabolism

- Dalmatian
- Dogs with primary hepatic disease

May lead to urate urolithiasis

#### Hyperxanthinuria (rare)

Seen in dogs receiving allopurinol to prevent urate uroliths

Congenital hyperxanthinuria seen in a family of Cavalier King Charles Spaniels

#### Renal Glucosuria

Primary renal glycosuria (rare)

- Scottish Terrier, Basenji, Norwegian Elkhound, mixed breeds

#### Fanconi Syndrome

Inherited proximal tubular defect

Basenji most common

May lead to renal failure

#### Renal Tubular Acidosis

Rare tubular disorders that lead to hyperchloremic metabolic acidosis

- Proximal renal tubular acidosis
- Distal renal tubular acidosis

#### Nephrogenic Diabetes Insipidus

Any renal disorder that suppresses the kidneys' response to ADH

Congenital (rare)

Acquired

- Toxic (*Escherichia coli* endotoxin)
- Drugs (glucocorticoids, chemotherapeutics)
- Metabolic disease (hypokalemia, hypercalcemia)
- Tubular injury or loss (polycystic renal disease, bacterial pyelonephritis)
- Medullary washout

## Differentiating Acute from Chronic Renal Failure

### Acute Renal Failure

- History of ischemia
- History of exposure to toxin
- Active urine sediment
- Good body condition
- Hyperkalemia (if oliguric)
- Normal to increased hematocrit
- Enlarged kidneys
- Potentially severe metabolic acidosis
- Severe clinical signs for level of dysfunction
- Normal-sized parathyroid glands (ultrasound appearance)

### Chronic Renal Failure

- History of previous renal disease
- History of polyuria/polydipsia
- Small irregular kidneys
- Nonregenerative anemia
- Normal to hypokalemia
- Normal to mild metabolic acidosis
- Inactive urine sediment
- Weight loss/cachexia
- Mild clinical signs for level of dysfunction
- Enlarged parathyroid glands (ultrasound appearance)

## Renal Toxins in Dogs and Cats

### Therapeutic Agents

#### Antibacterial Agents

Aminoglycosides  
Sulfonamides  
Nafcillin  
Penicillins  
Cephalosporins  
Fluoroquinolones  
Carbapenems  
Rifampin  
Tetracyclines  
Vancomycin

#### Antifungal Agents

Amphotericin B

#### Antiviral Agents

Acyclovir

Foscarnet

### **Antiprotozoal Agents**

Pentamidine

Sulfadiazine

Trimethoprim-sulfamethoxazole

Dapsone

### **Anthelmintics**

Thiacetarsamide

### **Cancer Chemotherapeutics**

Cisplatin/carboplatin

Methotrexate

Doxorubicin

Azathioprine

### **Immunosuppressive Drugs**

Cyclosporine

Interleukin-2

### **NSAIDs**

### **ACE Inhibitors**

### **Diuretics**

### **Miscellaneous Agents**

Dextran 40

Allopurinol

Cimetidine

Apomorphine

Deferoxamine

Streptokinase

Methoxyflurane

Penicillamine

Acetaminophen

Tricyclic antidepressants

### **Radiocontrast Agents**

### **Nontherapeutic Agents**

### **Heavy Metals**

Lead

Mercury

Cadmium

Chromium

### **Organic Compounds**

Ethylene glycol

Carbon tetrachloride

Chloroform

Pesticides

Herbicides

Solvents

### **Miscellaneous Agents**

Mushrooms  
Snake venom  
Grapes/raisins  
Bee venom  
Lily

### **Pigments**

Hemoglobin/myoglobin

### **Hypercalcemia**

## **Causes of Acute Renal Failure in Dogs and Cats**

### **Primary Renal Disease**

#### **Infection**

Pyelonephritis  
Leptospirosis  
Infectious canine hepatitis  
Borreliosis  
FIP

#### **Immune-Mediated Disease**

Acute glomerulonephritis  
SLE  
Renal transplant rejection

#### **Renal Neoplasia**

Lymphoma

#### **Nephrotoxicity**

Exogenous toxins  
Endogenous toxins  
Drugs

#### **Renal Ischemia**

#### **Prerenal Azotemia**

Dehydration/hypovolemia  
Deep anesthesia  
Sepsis  
Shock/vasodilation  
Decreased oncotic pressure  
Hyperthermia  
Hypothermia  
Hemorrhage  
Burns  
Transfusion reaction

#### **Renal Vascular Disease**

Avulsion  
Thrombosis

Stenosis

## **Systemic Diseases with Renal Manifestations**

Infection

- Bacterial endocarditis
- FIP
- Borreliosis
- Babesiosis
- Leishmaniasis

Pancreatitis

Diabetes mellitus

Hyperadrenocorticism

Hypoadrenocorticism

Hypocalcemia

Hypokalemia

Hypomagnesemia

Hyponatremia

SIRS

Sepsis

Multiple organ failure

DIC

Heart failure

SLE

Hepatorenal syndrome

Malignant hypertension

Hyperviscosity syndrome

- Polycythemia
- Multiple myeloma

Urinary outflow obstruction

Envenomation

## **Causes of Chronic Renal Failure in Dogs and Cats**

Inflammatory/infectious

- Pyelonephritis
- Leptospirosis
- Blastomycosis
- Leishmaniasis
- FIP

Familial/congenital (see p. 279)

Amyloidosis

Neoplasia

- Lymphosarcoma
- Renal cell carcinoma
- Nephroblastoma
- Tumor lysis syndrome
- Others

Nephrotoxics (see p. 281)

Renal ischemia

Sequela of acute renal failure

Glomerulopathies (see p. 273)

Nephrolithiasis

Bilateral hydronephrosis

- Spay granulomas
- Transitional cell carcinoma at trigone obstructing both ureters
- Nephrolithiasis

Polycystic kidney disease



Urinary outflow obstruction  
Idiopathic

# Reproductive Disorders

## Infertility—Differential Diagnosis, Canine Female

### Normal Cycles

- Improper breeding management
- Failure to determine optimal breeding time
- Female behavior
- Infertile male
- Elevated diestrual progesterone
  - Early embryonic death
  - Lesions in tubular system (vagina, uterus, uterine tubes)
  - Placental lesions (brucellosis, herpes)
- Normal diestrual progesterone
  - Cystic follicles (ovulation failure)

### Abnormal Cycles

#### Abnormal Estrus

##### Will Not Copulate

- Not in estrus
- Inexperience
- Partner preference
- Vaginal anomaly
- Hypothyroidism (possibly)

##### Prolonged Estrus

- Cystic follicles
- Ovarian neoplasia
- Exogenous estrogens
- Prolonged proestrus

##### Short Estrus

- Observation error
- Geriatric
- Ovulation failure
- Split estrus

#### Abnormal Interestrual Interval

##### Prolonged Interval

- Photoperiod (queen)
- Pseudopregnant/pregnant (queen)
- Normal breed variation
- Glucocorticoids (bitch)
- Old age
- Luteal cysts

##### Short Interval

- Normal (especially queen)
- Ovulation failure (especially queen)
- Corpus luteum failure
- “Split heat” (bitch)
- Exogenous drugs

## **Not Cycling**

Prepubertal  
Ovariohysterectomy  
Estrus suppressants  
Silent heat  
Unobserved heat  
Photoperiod (queen)  
Intersex (bitch)  
Ovarian dysgenesis  
Hypothyroidism (possibly)  
Glucocorticoid excess  
Hypothalamic-pituitary disorder  
Geriatric

## **Infertility—Differential Diagnosis, Canine Male**

### **Inflammatory Ejaculate**

Prostatitis  
Orchitis  
Epididymitis

### **Azoospermia**

Sperm-rich fraction not collected  
Sperm not ejaculated

- Incomplete ejaculation
- Obstruction
- Prostate swelling

Sperm not produced

- Endocrine
- Testicular
- Metabolic disorders

### **Abnormal Motility/Abnormal Morphology**

Iatrogenic  
Prepubertal  
Poor ejaculation  
Long abstinence

### **Abnormal Libido**

Female not in estrus  
Behavioral  
Pain  
Geriatric

### **Normal Libido**

Improper stud management  
Infertile female

### **Normal Libido/Abnormal Mating Ability**

Orthopedic  
Neurologic  
Prostatic disease  
Penile problem  
Prepuce problem

## Penis, Prepuce, and Testes Disorders—Differential Diagnosis

### Acquired Penile Disorders

Penile trauma

- Hematoma
- Laceration
- Fracture of os penis

Priapism (abnormal, persistent erection)

Neoplasia

Vesicles

Warts

Ulcers

Penile urethral obstruction

### Congenital Penile Disorders

Persistent penile frenulum

Penile hypoplasia

Hypospadias (defect in closure of urethra)

Diphallia (duplication of penis)

### Preputial Disorders

Balanoposthitis

- Bacterial infection
- Blastomycosis
- Canine herpesvirus

Phimosis

Paraphimosis

### Testicular Disorders

Cryptorchidism

Orchitis/epididymitis

- *Mycoplasma* spp.
- *Brucella canis*
- *Blastomyces* spp.
- *Ehrlichia* spp.
- Rocky Mountain spotted fever
- FIP

Testicular torsion

Testicular neoplasia

- Sertoli cell tumor
- Leydig cell tumor
- Seminoma

## Drugs and Metabolic Disorders Affecting Male Reproduction

Glucocorticoids (hyperadrenocorticism, exogenous glucocorticoids)

Decreased luteinizing hormone (LH), testosterone, sperm output, seminal volume, and libido;  
increased sperm abnormalities

Estrogens, androgens, anabolic steroids

Decreased LH, testosterone, and spermatogenesis

Cimetidine

Decreased testosterone, libido, and sperm count

Spironolactone, anticholinergics, propranolol, digoxin, verapamil, thiazide diuretics,  
chlorpromazine, barbiturates, diazepam, phenytoin, primidone

Decreased testosterone and libido

Progestogens, ketoconazole

Decreased testosterone

Amphotericin B, many anticancer drugs  
Decreased spermatogenesis  
Diabetes mellitus  
Decreased libido and sperm count, abnormal semen  
Renal failure, stress  
Decreased libido and sperm count

# Ureteral Diseases

## Differential Diagnosis

### Vesicoureteral Reflux

Primary: 7-12 weeks old — intrinsic maldevelopment of ureterovesical junction, self-limiting  
Secondary to lower urinary tract obstruction, UTI, surgical damage, neurologic disease of bladder, ectopic ureters

### Congenital Anomalies

Ectopic ureters  
Ureterocele  
Ureter agenesis  
Ureter duplication  
Urethrorectal or urethrovaginal fistula

### Acquired Ureteral Disease

Ureteral trauma

- Blunt trauma
- Penetrating trauma
- Iatrogenic damage during surgery

Inadvertent ligation and transection during ovariectomy

Urinoma (paraureteral pseudocyst)

Ureteral obstruction

- Intraluminal (blood clot, calculus)
- Intramural (fibrosis, stricture, neoplasia)
- Extramural (retroperitoneal mass, bladder neoplasia, inadvertent ligature)

Calculi (nephroliths or nephrolith fragments that have migrated into the ureter)

- Calcium oxalate (most common in cat)
- Struvite (both struvite and calcium oxalate are most common in dog)

Neoplasia

- Transitional cell carcinoma
- Leiomyoma
- Leiomyosarcoma
- Sarcoma
- Mast cell tumor
- Fibroepithelial polyp
- Benign papilloma
- Metastatic neoplasia

# Urinary Tract Infection

## Clinical Findings

### Lower UTI

Dysuria  
Pollakiuria  
Urge incontinence/inappropriate urination  
Gross hematuria at end of micturition  
Cloudy urine  
Foul odor to urine  
Small, painful, thickened bladder  
Palpable urocystoliths  
Asymptomatic  
Pyuria  
Hematuria  
Proteinuria  
Bacteriuria  
Normal CBC

### Upper UTI

Polyuria/polydipsia  
Signs of systemic illness or infection  
Possible renal failure  
Fever  
Abdominal pain  
Kidneys normal to enlarged  
Leukocytosis  
Pyuria  
Hematuria  
Proteinuria  
Bacteriuria  
Cellular or granular casts  
Decreased urine specific gravity

### Acute Prostatitis or Prostatic Abscess

Urethral discharge independent of micturition  
Signs of systemic illness/infection  
Fever  
Painful prostate or abdomen  
Tenesmus  
Prostatomegaly/asymmetry  
Leukocytosis ( $\pm$ )  
Pyuria  
Hematuria  
Proteinuria  
Bacteriuria  
Inflammatory prostatic cytology

### Chronic Prostatitis

Recurrent UTIs  
Urethral discharge independent of urination  
Possible dysuria  
Normal CBC  
Pyuria

Hematuria  
Proteinuria  
Bacteriuria  
Prostatomegaly/asymmetry

## Canine Lower Urinary Tract Disease—Differential Diagnosis

### Urocystoliths

Struvite (magnesium ammonium phosphate)  
Calcium oxalate  
Purine (urate/xanthine)  
Cystine  
Calcium phosphate  
Silica  
Compound uroliths

### Urethral Obstruction

Urethroliths (*see* Urocystoliths)  
Blood clots  
Urethral stricture  
Neoplasia

- Transitional cell carcinoma
- Prostatic adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Prostatic adenocarcinoma
- Squamous cell carcinoma
- Myxosarcoma
- Lymphoma
- MCT

Proliferative urethritis  
Urinary bladder entrapment in perineal hernia  
Trauma

- Penile fracture

### Urinary Tract Trauma

Contusion (bladder or urethra)  
Urethral tears  
Rupture of bladder (blunt trauma, secondary to pelvic fracture, penetrating wound)  
Avulsion of bladder or urethra  
Penile fracture

### Inflammation (Bladder or Urethra)

Bacterial UTI  
Fungal UTI  
Polypoid cystitis  
Emphysematous cystitis  
Cyclophosphamide-induced cystitis  
Parasitic cystitis (*Capillaria plica*)

## Feline Lower Urinary Tract Disease—Differential Diagnosis

Feline idiopathic cystitis  
Urethral plug (obstructive feline idiopathic cystitis)  
Urolithiasis

- Struvite
- Calcium oxalate



- Urate
- Cystine

Bacterial cystitis (less common in cats than in dogs)

Stricture

Neoplasia

## Uroliths, Canine

### Characteristics

#### Calcium Oxalate Monohydrate or Dihydrate

Radiopaque

Acidic to neutral pH

Sharp projections or smooth uroliths; calcium oxalate dihydrate uroliths may be jackstone shaped

Not associated with urinary tract infection

Calcium oxalate dihydrate crystals: square envelope shape

Calcium oxalate monohydrate crystals: dumbbell shaped

#### Struvite (Magnesium-Ammonium-Phosphate)

Radiopaque

Alkaline pH

Smooth to speculated if single; smooth and pyramidal in shape if multiple

Associated with infection with urease-producing bacteria (*Staphylococcus*, *Proteus*, *Ureaplasma* spp., *Klebsiella*, *Corynebacterium*)

“Coffin lid”-shaped crystals

#### Urate/Xanthine

Radiolucent to faintly radiopaque

Acidic pH

Smooth uroliths

Not associated with infection

Yellow-brown “thorn apple” (spherical) or amorphous crystals

#### Cystine

Faintly to moderately radiopaque

Acidic pH

Smooth, round uroliths; staghorn-shaped uroliths if nephroliths present

Not associated with infection

Hexagonal-shaped crystals

#### Calcium Phosphate

Radiopaque

Alkaline to normal pH for hydroxyapatite, acidic for brushite

Small, variably shaped uroliths for hydroxyapatite

Smooth, round or pyramidal for brushite

Not associated with infection

Amorphous phosphate crystals or thin prisms (calcium phosphate)

#### Silica

Radiopaque

Acidic to neutral pH

Jackstone-shaped uroliths

Not associated with infection

No crystals

# Vaginal Discharge

## Differential Diagnosis

### Cornified Epithelial Cells

Normal proestrus  
Normal estrus  
Contamination of skin or epithelium  
Ovarian remnant syndrome  
Abnormal source of estrogen

- Exogenous
- Ovarian follicular cyst
- Ovarian neoplasia

Contamination of squamous epithelium

### Mucus

Normal late diestrus or late pregnancy  
Normal lochia  
Mucometra  
Androgenic stimulation

### Neutrophils

#### Nonseptic (no microorganisms seen)

Vaginitis  
Normal first day of diestrus  
Metritis or pyometra

#### Septic

Vaginitis  
Metritis  
Pyometra  
Abortion

### Peripheral Blood

Subinvolution of placental sites  
Uterine or vaginal neoplasia  
Trauma to reproductive tract  
Uterine torsion  
Coagulopathies

### Cellular Debris

Normal lochia  
Abortion

---

## SECTION XV

# Pain Diagnosis

---

Acute Pain Assessment

Acute Pain Preemptive Scoring System (examples in each category)

Chronic Pain Assessment

## Acute Pain Assessment

Subjective evaluation of pain in animals relies on observation and interpretation of animal behavior.

Pain may be indicated by loss of normal behaviors or appearance of abnormal behaviors.

### Dogs

- Restless, agitated, delirious, circling, thrashing
- Lethargic, withdrawn, dull, obtunded
- May ignore environmental stimuli
- Abnormal sleep–wake cycle, inability to sleep
- May bite, lick, or chew painful area
- Adopt abnormal body positions to cope with pain, hunched posture, “prayer position”
- Abnormal tail position
- Lameness, abnormal gait
- Anorexia, reluctant to eliminate
- Ears held back, eyes wide open with dilated pupils or closed with a dull appearance
- Disuse or guarding of painful area
- Vocalization (whimper, yelp, whine, groan, yowl)
- May become more aggressive and resist handling or palpation or may become more timid and seek increased contact with caregivers

### Cats

- Hide, stay to back of cage
- Behavior may be mistaken for fear or anxiety
- May sit very quietly, and pain may be missed by those looking for more active signs of pain
- May continue to purr while in pain
- May growl with ears flattened
- May attempt escape
- Lack of grooming
- Hunched posture, statuelike appearance
- Reduced or absent appetite
- Tail flicking

## **Acute Pain Preemptive Scoring System (examples in each category)**

### **Minor Procedures: No Pain**

- Physical examination, restraint
- Radiography
- Suture removal, cast application, bandage change
- Grooming
- Nail trim

### **Minor Surgeries: Minor Pain**

- Suturing, debridement
- Urinary catheterization
- Dental cleaning
- Ear examination and cleaning
- Abscess lancing
- Removing cutaneous foreign bodies

### **Moderate Surgeries: Moderate Pain**

- Ovariohysterectomy, castration, caesarean section
- Feline onychectomy
- Cystotomy
- Anal saccullectomy
- Dental extraction
- Cutaneous mass removal
- Severe laceration repair
- Eye surgery, enucleation

### **Major Surgeries: Severe Pain**

- Fracture repair, cruciate ligament repair
- Thoracotomy, laminectomy, exploratory laparotomy
- Limb amputation
- Ear canal ablation

## Chronic Pain Assessment

- Clinical signs of chronic pain depend on underlying cause and pathologic state.
- Range from subtle to obvious
- May see acute flareups that require changes in treatment (e.g., osteoarthritic dog that experiences acute pain after excessive strenuous activity)
- Decreased activity
- Reluctance to rise or play
- Changes in sleep patterns
- Changes in appetite
- Changes in social interaction and grooming habits
- Withdrawal, aggression
- Owner observations are extremely important

---

## SECTION XVI

# FAST Ultrasound

---

FAST ultrasound examinations (Focused Assessment with Sonography for Trauma, Triage, and Tracking)



## **FAST ultrasound examinations (Focused Assessment with Sonography for Trauma, Triage, and Tracking)**

### **GFAST (Global FAST) is the combination of AFAST, TFAST, and Vet BLUE**

GFAST should be used as an extension of the physical exam in sick or injured patient. With training, all three FAST exams can be completed in about 5 minutes.

### **AFAST (Abdominal FAST)**

#### **Procedure**

- Patients are placed in either lateral recumbency; right is preferred because the basic echo views, gallbladder, caudal vena cava, left kidney are more easily imaged. Dorsal recumbency should not be used because of increased patient respiratory and hemodynamic stress.

Ultrasound probe is placed in four regions of abdomen:

1. Diaphragmatic-Hepatic (DH) view — at the level of the xiphoid, images the diaphragm, liver, gallbladder, caudal vena cava, pleural space, pericardial space, and lung
  2. Spleno-Renal (SR) view — images spleen, left kidney, abdominal and retroperitoneal space
  3. Cysto-Colic (CC) view — images bladder; however, an air-filled colon can confound imaging
  4. Hepato-Renal (HR) Umbilical view — images small intestine and spleen
- Probe is fanned in longitudinal (sagittal); transverse is not necessary
  - Purpose is quick assessment of AFAST target organs and detection of free abdominal and retroperitoneal fluid. Blood rapidly defibrinates in blunt trauma and nontrauma so it is seen as anechoic black triangulations. Penetrating trauma is different initially because blood often clots and blends in as soft tissue.

### **Abdominal fluid score (AFS)**

4-point scale where 0 means scanned negative for fluid at all four views and 4 means fluid detected at all 4 views

### **Application of AFS in medical vs. surgical decisions in bleeding dogs**

#### **Blunt trauma (think medical first)**

- AFS 1 and 2 are major injury, small volume bleeder — no blood transfusion needed, not expected to be anemic (PCV > 35%) if intraabdominal bleeding only. Reassess by AFAST and AFS (abdominal fluid score) to monitor for changes minimally 4 hours postadmission and sooner if unstable. If AFS stays 1-2 but PCV drops, look for bleeding at another site (retroperitoneal, pleural space, fracture site, external).
- AFS 3 and 4 are major injury, large volume bleeder (AFS 3-4 or becomes AFS 3-4). Expect anemia (PCV < 35%), use graduated fluid therapy (one third shock dose) and repeat titrated fluid challenges needed. With severe anemia (PCV < 25%) blood transfusion is often necessary, and surgery uncommon.

#### **Penetrating trauma (think surgery with any positive AFS)**

- Blood from ripping, tearing, crushing tends to clot, making it blend with adjacent tissue and difficult to detect by AFAST. With time clotted blood will defibrinate and become visible as black anechoic triangulations. Serial exams are key and should be performed as often as needed until certain the patient is medical and not surgical.
- Combine with other clinical findings such as hernia, refractory pain, septic abdomen, free air to

decide between surgical vs. medical.

### **Postinterventional bleeding—postsurgical, postpercutaneous biopsy/aspirate, laparoscopy, interventional radiology, bleeding tumor, etc. (think medical for AFS 1-2, surgical for AFS 3-4)**

- AFS 3 and 4 initially or on serial exams need surgical ligation of bleeding.
- AFS 1 and 2 that stays 1 or 2 with serial exams is not surgical.
- AFS 3 and 4 that are not anemic still need surgical exploration; waiting may lead to need for transfusion and additional risk and expense.
- Nontraumatic hemoabdomen (variably medical and surgical)
- Bleeding intraabdominal tumor, spleen most common, PCV generally low normal or low. Surgical problem.
- Canine anaphylaxis, newly described entity, PCV generally high normal or above normal. Look for gallbladder wall edema called *striation* or *halo sign*. Medical problem.
- Coagulopathy is an uncommon cause of nontraumatic hemoabdomen. Correct coagulopathy if present. Medical problem.

## **AFAST as an extension of the physical exam**

### **DH view**

- DH and CC views are most common positive sites in low-scoring dogs and cats.
- Useful for detecting pericardial effusion (racetrack sign) and pleural effusion
- Advantage: less air interference than transthoracic TFAST views
- Assessment of the weak or collapsed patient's volume status by observing dynamics of caudal vena cava (CVC) as it passes through diaphragm
  1. A distended caudal vena cava with little variability in its diameter supports a high central venous pressure (CVP) and hypervolemia; CVC is fat often accompanied by hepatic venous distension (tree trunk sign). Rule-outs include:
    - Right-sided volume overload
    - Pulmonary hypertension
    - Right-sided heart failure
    - Dilated cardiomyopathy
  2. An attenuated CVC with little variability in its diameter supports a low CVP and hypovolemia; CVC is flat
  3. The CVC normally has a change in its diameter of between 30% and 50%; in the ballpark of normal with a "bouncing" appearance
- Gallbladder is often adjacent the diaphragm on DH view
- May be displaced by an enlarged liver
- May be difficult to image with diaphragmatic hernia or gallbladder rupture, calculi/mineralization, or emphysema
- Feline gallbladders are more difficult to image on DH view.
- Gallbladder wall edema, intramural sonographic striation, has been referred to as the "*halo*" sign
- May be indicative of canine anaphylaxis in acute collapse/weakness
- May be indicative of right-sided heart failure, pericardial effusion/tamponade in acute collapse/weakness
- May be indicative of volume overload, third spacing, primary gallbladder disease, and pancreatitis in the less acute patient
- Liver masses, cysts, and diffuse or irregular changes in echogenicity may be appreciated

### **SR view**

- Least gravity-dependent view where air would rise to (pneumoabdomen) and fluid only at this site may be retroperitoneal rather than intraabdominal
- Acoustic window into the abdominal and retroperitoneal space for free abdominal fluid and retroperitoneal fluid

- Splenic masses and diffuse or irregular changes in echogenicity may be appreciated.
- Left kidney may appreciate variety of pathology, including hydronephrosis, pyelectasia, cortical cysts, perinephric cysts, masses, mineralization, calculi, and mineralization.
- May be able to also see right kidney in small dogs and cats through the SR view

## CC view

- CC and DH views are most common positive site in low-scoring dogs and cats.
- Urinary bladder may appreciate variety of lesions such as calculi, masses, wall thickening/abnormalities, and emphysema.

## HR Umbilical View

- Spleen and small intestine most often visible here
- Splenic masses and diffuse or irregular changes in echogenicity may be appreciated.
- Small intestine pathology may be appreciated, including dilated loops (ileus, obstruction), wall thickening, masses, and related lymph nodes.
- The name of this view is a misnomer because the liver and right kidney are not typically imaged.
- Liver and right kidney are normally not present at the level of the umbilicus unless they are enlarged.
- Stomach is not visible at the level of the umbilicus unless it's distended.
- The HR umbilical view completes AFAST and is likely the region to perform abdominocentesis in higher-scoring dogs and cats.

## TFAST (Thoracic FAST)

### Procedure

- Patients may be positioned in right or left lateral recumbency, especially if TFAST exam PCS views immediately follow the AFAST exam in stable patients, and in respiratory-compromised patients, and for the chest tube site (CTS) view; sternal recumbency or standing positioning is safer and preferred for the entire TFAST examination.
- Ultrasound probe is placed in five positions:
  1. Diaphragmatico-Hepatic (DH) view—immediately caudal to the xiphoid (same as AFAST DH view). Useful for detecting pericardial effusion (racetrack sign) and pleural effusion.
  2. Left and right CTS views—at the level of the seventh to eighth intercostal spaces at the highest point, upper third of the thorax, where lung may be visualized on the dorsolateral thoracic wall in the absence of pneumothorax, and where the cap of air would rise in the presence of pneumothorax
- If evidence of lung against the thoracic wall is observed sonographically, then pneumothorax is effectively ruled out.
- If there is no evidence that lung is against the thoracic wall, then the lung point is searched for where the transition zone is between pneumothorax and lung recontacting the thoracic wall.
- 3. Left and right PCS (pericardial site) view—over the heart at the level of the fifth and sixth intercostal spaces in gravity-dependent regions of the thorax
- PCS views are used for quick assessment of lungs, heart, pleural, and pericardial spaces.

## TFAST as an extension of the physical exam

### DH view

- Part of both AFAST and TFAST examinations—*see* AFAST DH view
- Useful for sonographic confirmation of pleural effusion and pericardial effusion (racetrack sign)
- Less air interference than TFAST transthoracic PCS views, liver and gallbladder provide acoustic window into thorax
- Allows for assessment of volume status by observing dynamics of the caudal vena cava (see DH view in AFAST as an extension of exam).

### CTS view

- Useful for ruling out pneumothorax and for surveying for lung lesions.
- Probe is placed perpendicular to the long axis of the adjacent ribs in order to image the intercostal space
- The orientation obtained is referred to as the *gator (alligator) sign* from the image created by rounded rib heads as the gator's eyes and the intercostal space, a white line, as the gator bridge of its nose, likened to a partially submerged alligator peering at the sonographer.
- Glide sign—normal to-and-fro motion of lung along the intercostal space or more specifically the movement of parietal and visceral pleural ruling out pneumothorax. Absence of the glide sign suggests pneumothorax.
- Ultrasound lung rockets (ULR, also called *B-lines*)—hyperechoic streaks that extend from pleural line through the far field that oscillate like a pendulum in synchrony with respiration
  1. Trauma-associated ULRs immediately rule out pneumothorax at that level of the thorax and support lung contusions until proven otherwise.
  2. In nontrauma ULRs (also called *B-lines*) represent various forms of alveolar-interstitial edema, including left-sided CHF, hemorrhage, variety of pneumonias, inflammation, as more common causes (*see* Vet BLUE)
- Step sign—deviation from the expected linear pulmonary–pleural interface
  1. Chest wall trauma or disease (intercostal tears, fractured ribs, subpleural hematoma)
  2. Pleural space disease (effusion, diaphragmatic hernia, masses)
- Lung point—location or transition zone at which collapsed lung secondary to pneumothorax recontacts thoracic wall
  1. Move probe ventrally to middle, then ventral or lower third of the thorax with patient standing or sternal until evidence of lung against the thoracic wall is found, then move incrementally dorsally until lung is lost to determine the exact lung point
  2. Use the lung point to assess and monitor pneumothorax; upper one third trivial to mild; middle one third is moderate; lower one third is severe.

### PCS views

- Used to visualize the heart, pericardial space, and pleural space
- Assess for pericardial or pleural effusion combining with the DH view.
- Increase depth so that the heart is seen in its entirety to avoid false positives from mistaking right ventricle/other heart chambers for effusion.
- TFAST echo views: left ventricular short axis view to assess volume status and contractility; long axis four-chamber view to assess for right-sided conditions; short-axis LA:Ao ratio for left-sided conditions.

## Clinical indications and applications of TFAST

- Blunt trauma
- Penetrating trauma
- Undifferentiated hypotension
- Collapse/apparent collapse
- Acute cardiopulmonary decompensation

- Pulmonary contusion
- Detection of atrial tears
- Postinterventional (thoracic surgery, lung lobe aspirate, thoracoscopy, tracheal wash, thoracentesis, chest tube)
- Monitoring pneumothorax
- Pleural and pericardial effusion
- Detecting and monitoring forms of pulmonary edema and respiratory distress
- Patient monitoring during fluid resuscitation

## Vet BLUE lung ultrasound

### Procedure

- Probe is positioned as described at the TFAST CTS view but then moved through three more views bilaterally.
- Vet BLUE has eight total acoustic views (four views bilaterally).
  1. Cd (caudodorsal lung region)—same as TFAST CTS view, upper third of the thorax at the level of the eighth to ninth intercostal spaces directly above the xiphoid near the highest point where lung may be visualized on the dorsolateral thoracic wall
  2. Ph (perihilar lung region)—sixth to seventh intercostal space, middle third of the thorax
  3. Md (middle lung region)—fourth to fifth intercostal space, lower third of the thorax
  4. Cr (cranial lung region)—second to third intercostal space, lower third of the thorax
- The most recent, most accurate described methodology by the originator of the Vet BLUE is to begin by finding the transition zone in a standing (or sternal) patient at the CTS/Cd view where abdominal contents and lung are viewed over an intercostal space, then sliding toward the head two intercostal spaces to begin the Vet BLUE at the Cd view (point 1).
- From the Cd view (point 1) draw an imaginary line to the elbow. Halfway from the Cd to the elbow is the Ph view (point 2), and at the elbow is the Md view (point 3) and then in the axillary area as the final Cr view. If the heart is in view at the Md, slide the probe directly dorsally until over lung for the Md view, and define the Cr view by finding the transition of lung and thoracic inlet, then sliding caudally over the first two intercostal spaces. If a gator sign orientation is not observed, then you cannot be assured lung is being imaged.

## Vet BLUE lung ultrasound findings in progression from most to least aerated/most consolidated

- Dry lung—glide sign with A-lines (reverberation artifact) at lung line indicates dry lung at the lung periphery. The confounder: A-lines with no glide sign consistent with pneumothorax
- Wet lung ULRs (also called *B-lines*)—hyperechoic streaks that oscillate with respiration and extend to the far field, obliterating A-lines
- Shred sign—deviation of the lung line (pulmonary-pleural line) and within the deviation hyperechoic foci of air movement seen in bronchi. Comparable to a radiographic air bronchogram. Indicates lung consolidation/infiltration.
- Tissue sign—more severe consolidation/infiltration where no air movement is present. Referred to as *hepatization of lung*.
- Nodule sign—anechoic round (nodule) often with a hyperechoic far border and acoustic enhancement through the far field as a ULR.

## Vet BLUE differential diagnosis for patients with respiratory signs with dry lung in all fields

### Respiratory

- Upper airway disease (laryngeal paralysis, collapsing trachea)
- Airway obstruction (mass)
- Feline asthma
- Chronic obstructive pulmonary disease
- Pulmonary thromboembolism

- Centrally located lung lesion away from lung line, therefore missed by Vet BLUE

### **Cardiac**

- Cardiac arrhythmia
- Dilated cardiomyopathy
- Cardiac tamponade

### **Undifferentiated hypotension**

- Canine anaphylaxis
- Cavitory hemorrhage (hemoabdomen, hemothorax, hemoretroperitoneum)
- Sepsis

### **Other nonrespiratory**

- High fever
- Heat stroke
- Severe metabolic acidosis
- Severe anemia

## **GFAST Triad for volume status and patient monitoring**

GFAST, the name for the use of AFAST and its fluid scoring system, TFAST and Vet BLUE combined, may be used for rapid patient volume status assessment during, before, and after fluid resuscitation.

- Characterization of CVC and hepatic veins for estimation of CVP (see earlier); forms of shock (e.g., hypovolemic/distributive shock/cardiogenic/obstructive shock)
- TFAST—assessment of cardiac views for volume and contractility, right- and left-sided conditions (see [TFAST](#))
- Vet BLUE—presence of wet lung screens for left-sided cardiac overload, and the pattern-based approach and Vet BLUE lung ultrasound signs help determine CHF, pneumonia, neoplasia, granulomatous conditions, PTE (pulmonary thromboembolism), and others

FAST Ultrasound edited by Gregory R. Lisciandro, DVM, Dipl. ABVP, Dipl. ACVECC of Hill Country Veterinary Specialists, [FASTVet.com](#) and editor of textbook *Focused Ultrasound Techniques for the Small Animal Practitioner*, Wiley © 2014.

---

## PART THREE

# Laboratory Values and Interpretation of Results

---

**Note:**

Normal ranges are meant to provide the reader with an approximation of normal. Individual laboratory values should be compared with the reference range values of the laboratory that performed the test.



## **Acetylcholine Receptor Antibody**

## Normal range:

Feline: < 0.3 nmol/L

Canine: < 0.6 nmol/L

## Elevated in:

myasthenia gravis

## Note:

A positive titer is diagnostic for myasthenia gravis. Negative titers occur in 10% to 20% of positive cases; therefore a negative titer does not exclude myasthenia gravis.

## **Activated Coagulation Time (ACT)**

## Normal range:

Feline: < 165 seconds

Canine: 60-110 seconds

Screening test for intrinsic and common coagulation pathways (factors II, V, VIII, IX, X, XI, XII);  
may also be prolonged with severe thrombocytopenia and decreased fibrinogen.

## **Activated Partial Thromboplastin Time (APTT)**

## Normal range:

Feline: 10-25 seconds

Canine: 10-25 seconds

Determines abnormalities in the intrinsic coagulation pathway

Prolonged with deficiencies in factors VIII, IX, XI, and XII and fibrinogen; also prolonged with disseminated intravascular coagulation (DIC)

Prolonged with von Willebrand disease (vWD), acquired vitamin K deficiency, coumarin poisoning, bile insufficiency, liver failure

Severely prolonged with hemophilia A (factor VIII deficiency) and hemophilia B (factor IX)

## **Adrenocorticotrophic Hormone (ACTH), Endogenous**

### **Normal range:**

Feline: not reported  
Canine: 10-70 pg/mL

### **Elevated in:**

pituitary-dependent hyperadrenocorticism, hypocortisolism

### **Decreased in:**

iatrogenic Cushing syndrome and adrenal tumors



## **Adrenocorticotrophic Hormone (ACTH) Stimulation Test**

## Normal range:

### Pre-ACTH injection:

Feline: 1.0-4.5 µg/dL

Canine: 1.0-4.5 µg/dL

### Post-ACTH injection:

Feline: 4.5-15.0 µg/dL (13-16 µg/dL: suggestive of hyperadrenocorticism, > 16 µg/dL strongly suggestive)

Canine: 5.5-20.0 µg/dL (18-24 µg/dL: suggestive of hyperadrenocorticism, > 24 µg/dL strongly suggestive)

From 15% to 20% are false-negative results; false-positive results may be seen with stress or nonadrenal illness.

Pre-ACTH cortisol is in normal range, and post-ACTH cortisol shows little to no change with iatrogenic Cushing syndrome.

Pre-ACTH cortisol is below normal, and post-ACTH cortisol shows little change with hypoadrenocorticism.

Pre-ACTH and post-ACTH cortisol levels should be between 1 and 5 µg/dL with successful Lysodren induction or while on maintenance Lysodren therapy.

Trilostane induction: < 1.45 µg/dL, stop treatment. Restart on a lower dose.

1.45-5.4 µg/dL, continue on same dose.

5.4-9.1 µg/dL, continue on current dose if clinical signs well controlled or increase dose if clinical signs of hyperadrenocorticism still evident.

> 9.1 µg/dL, increase initial dose.

### Note:

ACTH stimulation does not differentiate pituitary-dependent hyperadrenocorticism from adrenal tumors. The low-dose dexamethasone test is more diagnostic for canine Cushing syndrome.

## **Alanine Aminotransferase (ALT, Formerly SGPT)**

## Normal range:

Feline: 10-100 IU/L

Canine: 12-118 IU/L

## Elevated in:

hepatocellular membrane damage and leakage

*Inflammation:* chronic active hepatitis, lymphocytic/plasmacytic hepatitis (cats), enteritis, pancreatitis, peritonitis, cholangitis, cholangiohepatitis

*Infection:* bacterial hepatitis, leptospirosis, feline infectious peritonitis (FIP), infectious canine hepatitis

*Toxicity:* chemical, heavy metals, mycotoxins

*Neoplasia:* primary, metastatic

*Drugs*

*Endocrine:* diabetes mellitus, hyperadrenocorticism, hyperthyroidism

*Trauma*

*Hypoxia:* cardiopulmonary disease, thromboembolic disease

*Metabolism:* feline hepatic lipidosis, storage diseases (e.g., copper)

*Liver lobe torsion*

*Hepatocellular regeneration*

*Cirrhosis*

## Decreased in:

end-stage liver disease, but in most cases decreased ALT is not significant

## Albumin

## Normal range:

Feline: 2.5-3.9 g/dL

Canine: 2.7-4.4 g/dL

## Elevated in:

dehydration (globulin and total protein should also be increased), spurious (e.g., hemolysis, lipemia, laboratory error), higher in adults than in juveniles

## Decreased in:

protein-losing nephropathy (amyloidosis, glomerulonephritis, glomerulosclerosis), gastroenteropathy (malabsorption, maldigestion, protein-losing enteropathy), liver failure, malnutrition (dietary, parasitism), exudative skin disease (vasculitis, burns, abrasions, degloving injury), neonates, external blood loss, compensatory (chronic effusions, hyperglobulinemia, multiple myeloma)

## **Alkaline Phosphatase, Serum (SAP or ALP)**

## Normal range:

Feline: 6-102 IU/L

Canine: 5-131 IU/L

Elevated in biliary tract abnormalities (pancreatitis, bile duct neoplasia, cholelithiasis, cholecystitis, ruptured gallbladder); hepatic parenchymal disease (cholangitis/cholangiohepatitis, chronic hepatitis, nodular hypoplasia, copper storage disease, hepatic lipidosis [cats], cirrhosis, hepatic neoplasia [lymphoma, hemangiosarcoma, hepatocellular carcinoma, metastatic carcinoma], toxic hepatitis, FIP [cats]); corticosteroids; anticonvulsants (phenobarbital, primidone); endocrine disorders (diabetes mellitus, hyperadrenocorticism [dogs], hyperthyroidism [cats]); enteritis; bone isoenzyme; young dog with bone growth; osteosarcoma; osteomyelitis; ehrlichiosis; diaphragmatic hernia; passive congestion due to right heart failure; iatrogenic

## Note:

Almost any disorder that affects the liver can cause elevations in SAP levels.



## Ammonia

## Normal range:

Feline: 30-100 µg/dL  
Canine: 45-120 µg/dL

## Elevated in:

hepatic failure (portosystemic shunt, cirrhosis); postprandial, postexercise (racing dogs), spurious (e.g., hemolysis, lipemia, laboratory error)

## Note:

Due to instability of samples, this test has been mostly been replaced by serum bile acids.

## Amylase, Serum

## Normal range:

Feline: 100-1200 U/L  
Canine: 290-1125 U/L

## Elevated in:

pancreatitis, pancreatic neoplasia, pancreatic duct obstruction, pancreatic necrosis, enteritis, renal disease (decreased filtration of amylase)

## Note:

Serum amylase levels may not correlate with severity of disease. Not very sensitive or specific, especially in cats

## Anion Gap

## **Normal range:**

Feline: 12-24 mEq/L

Canine: 16.3-28.6 mEq/L

## Laboratory calculation:

$$[\text{Na} + \text{K}] - [\text{Cl} + \text{HCO}_3^-] = \text{Anion gap}$$

### Elevated in:

Metabolic acidosis from acids that do not contain chloride (lactic acidosis, uremia, ketoacidosis, ethylene glycol toxicosis). Metabolic acidosis with normal anion gap has an increased plasma chloride concentration and is called *hyperchloremic acidosis*.

### Decreased in:

hypoalbuminemia, IgG multiple myeloma

## **Antinuclear Antibody (ANA)**



## Normal range:

Reported as a titer, very laboratory dependent. Refer to your laboratory for normal ranges. High positive titer, with associated clinical and clinicopathologic signs, supports a diagnosis of systemic lupus erythematosus (SLE). Many immune-mediated, inflammatory, and infectious diseases and neoplasms can result in low positive titers. Results may be false negative with chronic glucocorticoid use.

## **Antithrombin (AT)**

## Normal range:

Measured as a percentage of species-specific pooled samples

Dogs: 75%-120%

Cats: 75%-110%

## Elevated in:

- Exogenous glucocorticoid administration (dogs)
- Inflammation
- Elevation of antithrombin is not clinically significant

## Decreased in:

- Decreased production (hepatopathy, portosystemic shunt)
- Increased loss (protein-losing nephropathy, glomerulonephritis, renal amyloidosis, protein-losing enteropathy)
- Increased hepatic clearance of antithrombin enzyme complexes (disseminated intravascular coagulation [DIC], sepsis)

Often decreased in patients with DIC, nephrotic syndrome, and thrombosis. AT levels of < 70% of the control cause the patient to be unresponsive to heparin therapy without first providing AT replacement therapy.

## Arterial Blood Gases

## Normal range:

	Canine	Feline
pH	7.35-7.45	7.36-7.44
PaCO <sub>2</sub>	36-44	28-32
PaO <sub>2</sub>	90-100	90-100
TCO <sub>2</sub>	25-27	21-23
HCO <sub>3</sub> <sup>-</sup>	24-26	20-22

## Blood gas interpretation:

### Evaluate PaO<sub>2</sub>

#### Hypoxemia:

arterial oxygen tension/partial pressure (PaO<sub>2</sub>) of less than 85 mm Hg

Emergency treatment for hypoxemia needed when PaO<sub>2</sub> is less than 60 mm Hg.

Cyanosis may be seen when PaO<sub>2</sub> is 50 mm Hg or lower, depending on hemoglobin concentration.

### Potential causes of hypoxemia

Right-left shunts (patent ductus arteriosus, ventricular septal defects, intrapulmonary shunts)

Ventilation/perfusion mismatch (various pulmonary diseases)

Diffusion impairment

Hypoventilation (anesthesia, neuromuscular disease, airway obstruction, central nervous system disease, pleural space or chest wall abnormality)

Decrease in fraction of inspired oxygen (hooked up to empty oxygen tank)

### Evaluate pH

Increase in pH: alkalemia (metabolic alkalosis or respiratory alkalosis)

Decrease in pH: acidemia (metabolic acidosis or respiratory acidosis)

### Assess acid-base status

#### If acidemic:

Arterial carbon dioxide tension (PaCO<sub>2</sub>) elevated: respiratory acidosis

PaCO<sub>2</sub> decreased: compensatory respiratory alkalosis

Bicarbonate (HCO<sub>3</sub><sup>-</sup>) decreased: metabolic acidosis

HCO<sub>3</sub><sup>-</sup> elevated: compensatory metabolic alkalosis

#### If alkalotic:

PaCO<sub>2</sub> decreased: respiratory alkalosis

PaCO<sub>2</sub> elevated: compensatory respiratory acidosis

HCO<sub>3</sub><sup>-</sup> elevated: metabolic alkalosis

HCO<sub>3</sub><sup>-</sup> decreased: compensatory metabolic acidosis

## **Aspartate Aminotransferase (AST, Formerly SGOT)**

Not considered clinically significant in the dog or cat

Very sensitive but not very specific; significant amounts of AST found also in muscle

## Bartonella

Bacteria of the genus *Bartonella* infect at very low levels, so even a highly sensitive polymerase chain reaction (PCR) assay may not detect bacterial DNA in the patient sample. Traditional testing methodologies such as immunofluorescence antibody (IFA) or Western blot analysis are therefore likely to produce false-negative results.

Preenrichment cultures of samples with *Bartonella alpha* Proteobacteria Growth Media (BAPGM) followed by PCR greatly improves sensitivity, and this methodology has become the gold standard for diagnosis. This combination of test methods increases the likelihood of detecting *Bartonella* infection by supporting the growth of any viable bacterium up to levels detectable by DNA amplification.

## Recommendations for Testing

- 1) Tissue and nonblood fluid samples: Preliminary testing results indicate that *Bartonella*-positive results from preenrichment and PCR are obtained more often from tissue and nonblood fluid samples than from blood. Accordingly, it is recommended to test specimens drawn from as close as possible to the area of disease pathology.
- 2) Triple draws: *Bartonella* cycles in a relapsing pattern of bacteremia. The odds of detecting a positive *Bartonella* infection are increased significantly by blood draws on 3 separate days over the course of a week, refrigerated, and submitted all at once for testing.
- 3) Serology testing: Although preenrichment and PCR testing significantly increase the odds of detecting active *Bartonella* infection, serologic testing for antibodies also provides important diagnostic support to confirm exposure and to potentially implicate infection that may have been missed by DNA testing. The best patient care information is obtained by combining results of serology and the preenrichment and PCR.
- 4) Posttreatment follow-up: *Bartonella* infections can be difficult to clear with either single or combination antibiotics. Follow-up testing is recommended 4-6 weeks after treatment or at regular intervals posttreatment depending on patient status.

Preenrichment and PCR testing and serologic testing are all available at GALAXY Diagnostics, [www.galaxydx.com](http://www.galaxydx.com).

## Basophil Count



## Normal range:

Feline: 0-150 cells/ $\mu$ L

Canine: 0-150 cells/ $\mu$ L

## Elevated (basophilia) in:

disorders associated with IgE production/binding (heartworm disease, atopy, flea allergy), allergic reactions (e.g., food, insect sting), inflammatory disease (gastrointestinal [GI] tract disease, respiratory tract disease), neoplasia (mast cell neoplasia, basophilic leukemia, lymphomatoid granulomatosis), associated with hyperlipoproteinemia and possibly hypothyroidism

## Bicarbonate ( $\text{HCO}_3^-$ )

## **Normal range:**

Feline: 20-22 mmol/L

Canine: 24-26 mmol/L

### **If acidemic:**

#### **Elevated in:**

metabolic alkalosis (with compensatory acidosis)

#### **Decreased in:**

metabolic acidosis

### **If alkalotic:**

#### **Elevated in:**

metabolic alkalosis

#### **Decreased in:**

metabolic acidosis (with compensatory alkalosis)

## Bile Acids

## Normal range:

### Preprandial:

Feline and canine: 0-5.0  $\mu\text{mol/L}$

### Postprandial:

Feline: 1-20.0  $\mu\text{mol/L}$

Canine: 5.0-25.0  $\mu\text{mol/L}$

### Elevated in:

hepatocellular disease, cholestatic disease, portosystemic shunt

### Decreased in:

delayed gastric emptying, malabsorption disorders, rapid intestinal transport, ileal resection

Patient must be fasted and cannot be icteric. Typically measure preprandial and 2-hour postprandial serum samples.

May also measure urine bile acids, although patients with portosystemic shunts tend to have lower urine bile acids than patients with hepatocellular disease.

## Bilirubin

## Normal range:

Feline: < 1.0 mg/dL  
Canine: < 1.0 mg/dL

## Elevated in:

prehepatic, hemolytic anemia, cholestasis (extrahepatic [pancreatitis, cholangitis, cholecystitis, cholelithiasis, biliary neoplasia], intrahepatic [nodular hyperplasia, feline hepatic lipidosis, cholangitis/cholangiohepatitis, cirrhosis, hepatic lymphoma, acute hepatic necrosis]), duodenal perforation, ruptured gallbladder

## Blood Urea Nitrogen (BUN)



## Normal range:

Feline: 14-36 mg/dL

Canine: 6-25 mg/dL

## Elevated in:

prerenal azotemia (dehydration, hypoadrenocorticism, heart failure, shock, GI hemorrhage, high-protein diet); increased catabolism (fever, drugs, [e.g., tetracycline]); renal failure; pyelonephritis; postrenal azotemia (urethral [obstruction, urolith, urethral tear, plant awn]; bladder [obstruction, urolith, blood clot, polyp, neoplasia, rupture])

## Decreased in:

diuresis (polydipsia, hyperadrenocorticism, overzealous fluid therapy, drugs [e.g., glucocorticoids], diabetes insipidus [DI]); liver failure (portosystemic shunt, cirrhosis, urea cycle enzyme deficiency); low-protein diet; malnutrition; neonates

## **Buccal Mucosal Bleeding Time (BMBT)**

## **Normal range:**

Feline and canine: < 3 minutes

Prolonged bleeding time is a sensitive and specific indicator of diminished platelet function (e.g., severe thrombocytopenia, vWD, and uremia).

## Calcium (Ca)

## Normal range:

Feline: 8.2-10.8 mg/dL

Canine: 8.9-11.4 mg/dL

## Elevated in:

primary hyperparathyroidism; renal failure; hypoadrenocorticism; hypercalcemia of malignancy (lymphosarcoma, apocrine gland adenocarcinoma, carcinomas [nasal, mammary gland, gastric, thyroid, pancreatic, prostate, pulmonary]; osteolytic [multiple myeloma, lymphosarcoma, squamous cell carcinoma, osteosarcoma, fibrosarcoma]); hypervitaminosis D (cholecalciferol rodenticides, plants, excessive supplementation); dehydration; granulomatous disease (systemic mycosis [blastomycosis], schistosomiasis, FIP); nonmalignant skeletal disorder (osteomyelitis, hypertrophic osteodystrophy [HOD]); iatrogenic disorder (excessive calcium supplementation, excessive oral phosphate binders); factitious disorders (serum lipemia, postprandial measurement, young animal); laboratory error; idiopathic (cats)

## Decreased in:

renal failure (acute and chronic); acute pancreatitis; intestinal malabsorption; primary hypoparathyroidism (idiopathic, postthyroidectomy); puerperal tetany (eclampsia); ethylene glycol toxicity; hypoproteinemia/hypoalbuminemia; hypomagnesemia; nutritional secondary hyperparathyroidism; tumor lysis syndrome; phosphate-containing enemas; anticonvulsant medications; hypovitaminosis D, rhabdomyolysis, sodium bicarbonate administration; laboratory error

## Cerebrospinal Fluid (CSF)

## Normal range:

Normal CSF is colorless and clear. Discoloration usually means red blood cells (RBCs) or neutrophils are present.

Value	Canine	Feline	Cytology (%)		
WBCs ( $\times 10^3/\text{L}$ )	$\leq 3$	$\leq 2$	Monocytes	87	69-100
RBCs ( $\times 10^6/\text{L}$ )	$\leq 30$	$\leq 30$	Lymphocytes	4	0-27
Protein (mg/dL)	$\leq 33$	$\leq 36$	Neutrophils	3	0-9
			Eosinophils	0	0
			Macrophages	6	0-3

*Infectious central nervous system (CNS) disease:* increased white blood cells (WBCs) and protein content

*Inflammatory CNS disease:* increased WBCs and protein content

*Brain neoplasia:* normal to mild elevation of WBCs, mild elevation of protein content

*Hydrocephalus, lissencephaly:* normal WBCs and protein content

*Degenerative myelopathy, intervertebral disk disease, polyradiculoneuritis:* normal WBCs and normal to mildly increased protein content

Most common cause of RBCs in CSF is contamination during collection.

## Chloride (Cl)



## Normal range:

Feline: 104-128 mEq/L

Canine: 102-120 mEq/L

Often changes proportionally with sodium. In those cases it is usually easier to search for the cause of the sodium change.

## Corrected Hyperchloremia (elevation of chloride disproportionate to elevation of sodium):

### Excessive Loss of Sodium Relative to Chloride

Small Bowel Diarrhea (common and important)

### Pseudohyperchloremia

Lipemic Samples Using Colorimetric Methods

Potassium Chloride Therapy (common and important)

### Excessive Gain of Chloride Relative to Sodium

Therapy with Chloride Salts ( $\text{NH}_4\text{Cl}$ ,  $\text{KCl}$ )

Total Parenteral Nutrition

Fluid Therapy (0.9%  $\text{NaCl}$ , hypertonic saline,  $\text{KCl}$ -supplemented fluids)

Salt Poisoning

Renal Chloride Retention (renal failure, renal tubular acidosis, hypoadrenocorticism, diabetes mellitus, chronic respiratory alkalosis, drug-induced [acetazolamide, spironolactone])

Exercise (endurance exercise in sled dogs, short, submaximal exercise [agility])

## Corrected Hypochloremia (loss of chloride relative to sodium)

### Gastrointestinal Loss

Vomiting of Stomach Contents

Selected GI diseases associated with hyperkalemia and hyponatremia in dogs without hypoadrenocorticism (trichuriasis, salmonellosis, perforated duodenal ulcer)

### Renal Loss

Therapy with Thiazide or Loop Diuretics

Chronic Respiratory Acidosis

Hyperadrenocorticism

Glucocorticoid Administration

### Therapy with Solutions with High Sodium Concentration Relative to Chloride

Sodium Bicarbonate

## Exercise in Racing Greyhounds

## Cholesterol (CH)

## **Normal range:**

Feline: 75-220 mg/dL

Canine: 92-324 mg/dL

## **Elevated in:**

postprandial, primary hyperlipidemia, endocrine disorders (hypothyroidism, hyperadrenocorticism, diabetes mellitus), cholestasis, dietary (high-cholesterol diet), nephrotic syndrome, protein-losing nephropathy, idiopathic (Doberman Pinscher, Rottweiler)

## **Decreased in:**

liver failure, malabsorption, maldigestion, protein-losing enteropathy, portosystemic shunt, lymphangiectasia, starvation, hypoadrenocorticism, selected malignancies

## Cholinesterase

### **Normal range:**

Feline: 500-4000 U/L  
Canine: 800-4000 U/L

### **Decreased in:**

organophosphate toxicity, carbamate toxicity

## Cobalamin

## **Normal range:**

Feline: 290-1499 pg/mL

Canine: 251-908 pg/mL

## **Decreased in:**

exocrine pancreatic insufficiency, distal small intestinal disease, diffuse small intestinal disease, small intestinal bacterial overgrowth (usually combined with an increased serum folate level), hepatic disease in cats



## **Complete Blood Count (CBC)**

## Normal range:

### Total WBC count:

Feline: 3.5-16.0  $10^3/\mu\text{L}$   
Canine: 4.0-15.5  $10^3/\mu\text{L}$

### Total RBC count:

Feline: 5.92-9.93  $10^6/\mu\text{L}$   
Canine: 4.8-9.3  $10^6/\mu\text{L}$

### Hemoglobin:

Feline: 9.3-15.9 g/dL  
Canine: 12.1-20.3 g/dL

### Hematocrit (packed cell volume [PCV]):

Feline: 29%-48%  
Canine: 36%-60%

### Reticulocyte count:

Feline: 0%-10.5% punctate or 0%-1.0% aggregate  
Canine: 0%-1.0% aggregate

### Mean corpuscular volume (MCV):

Feline: 37-61 fL  
Canine: 58-79 fL

### Mean corpuscular hemoglobin (MCH):

Feline: 11-21 pg  
Canine: 19-28 pg

### Mean corpuscular hemoglobin concentration (MCHC):

Feline: 30-38 g/dL  
Canine: 30-38 g/dL

### Platelet count:

Feline: 200-500  $10^3/\mu\text{L}$   
Canine: 170-400  $10^3/\mu\text{L}$

### Total solids:

Feline: 5.2-8.8 g/dL  
Canine: 5.0-7.4 g/dL

## **Coombs Test**

Indicates presence of antibody and/or complement on the surface of erythrocytes; supports the diagnosis of immune-mediated hemolytic anemia

## Cortisol

## **Normal range:**

Feline and canine: 1.0-4.5 µg/dL

Not a reliable indicator of disease; considerable overlap between normal patients and those with adrenal disease

## **Elevated in:**

stress (environmental, illness), drugs (prednisone and prednisolone [may cross-react in assay], anticonvulsants), pituitary- and adrenal-dependent hyperadrenocorticism

## **Decreased in:**

drugs (suppression of adrenal function), hypoadrenocorticism

## **Creatine Kinase (CK, formerly CPK)**

## Normal range:

Feline: 56-529 U/L

Canine: 59-895 U/L

## Elevated in:

trauma, myositis (immune mediated, eosinophilic myositis, masticatory muscle myositis, infectious [toxoplasmosis, neosporosis], endocarditis), exertional myositis, surgery (tissue damage), nutritional (hypokalemia [polymyopathy], taurine deficiency), prolonged recumbency, intramuscular injections, pyrexia, hypothermia, postinfarct ischemia (cardiomyopathy, DIC), muscle ischemia secondary to status epilepticus

## **Creatinine**



## **Normal range:**

Feline: 0.6-2.4 mg/dL

Canine: 0.5-1.6 mg/dL

## **Elevated in:**

azotemia (prerenal, renal, postrenal, rhabdomyolysis)

## **Decreased in:**

any condition that causes decreased muscle mass

# Cytologic Criteria of Malignancy

## General Criteria

- Anisocytosis and macrocytosis—variation in cell size
- Hypercellularity—increased cell exfoliation due to decreased cell adherence
- Pleomorphism—variable size and shape of cells of the same type

## Nuclear Criteria

- Macrokaryosis—increased nuclear size; nuclei larger than 20  $\mu$  suggestive of neoplasia
- Increased nucleus-to-cytoplasm ratio (N:C)—normal nonlymphoid cells have usually have a N:C of 1.3:1.8. Ratios of 1.2 or less suggestive of malignancy.
- Anisokaryosis—variation in nuclear size; especially important if the nuclei of multinucleated cells vary in size
- Multinucleation—especially important if the nuclei vary in size
- Increased mitotic figures—mitosis is rare in normal tissues
- Abnormal mitosis—improper alignment of chromosomes
- Coarse chromatin pattern—may appear ropy or cordlike
- Nuclear molding—deformation of nuclei by other nuclei within the same cell or adjacent cells
- Macronucleoli—nucleoli are increased in size ( $> 5 \mu$  suggestive of malignancy, for reference, RBCs are 5-6  $\mu$  in the cat and 7-8  $\mu$  in the dog)
- Angular nucleoli—fusiform or have other angular shapes instead of their normal round to slightly oval shape
- Anisonucleoliosis—variation in nucleolar shape or size (especially important if the variation is within the same nucleus)

# Cytologic Features of Discrete Cell (Round Cell) Tumors

## Discrete Cells (Round Cells)

- Present individually in tissues, not adhered to other cells for connective tissue matrix.
- Most discrete cells are of hematogenous origin.
- Aspirates of normal lymphoid tissues like spleen and lymph nodes yield discrete cells.
- Discrete cell patterns in other tissues indicate the presence of a discrete cell tumor (round cell tumor).
- Cells tend to be small to medium sized and round.

## Specific Discrete Cell Tumors

### Mast Cell Tumor

Highly cellular smears of predominately mast cells

- Small, red-purple intracytoplasmic granules
- Number of granules seen vary from few to so many the cytoplasm is packed with granules. Some mast cells may degranulate during aspiration. More granules in background, fewer in cells.
- Anaplastic mast cell tumors may be virtually devoid of granules.

### Lymphoma

Most cases of lymphoma in dogs and cats are high-grade tumors composed mostly of large blastic lymphoid cells. Cytology typically shows greater than 50% of cells are large, blastic lymphocytes. Lymphoblasts have a high nuclear-to-cytoplasmic ratio and intensely basophilic cytoplasm.

- Low-grade, well-differentiated lymphoma may yield predominately small lymphocytes. Such tumors are difficult to differentiate from normal or reactive lymphoid tissue and require biopsy and histopathology.

### Canine Cutaneous Histiocytoma

Benign tumors of dendritic cell origin, common in young dogs

- Medium-sized cells, round to oval nuclei that may be indented. Finely stippled chromatin with indistinct nucleoli. Moderate amount of light blue-gray cytoplasm.
- Most histiocytomas regress spontaneously. The presence of small lymphocytes with these tumor cells may be seen in tumors that are regressing.

### Malignant Histiocytosis/Histiocytic Sarcoma/Systemic Histiocytosis

Cytologic appearance varies from benign-looking cells to populations of histiocytic cells with marked atypia.

- Common features include large discrete cells with abundant vacuolated cytoplasm, prominent cytophagia, and multinucleation. May demonstrate marked anisocytosis, anisokaryosis, and variation of nuclear:cytoplasmic ratio. Macrocytosis, karyomegaly, and large multinucleated cells are common.
- Definitive diagnosis may not be possible based on cytology alone.

### Plasmacytoma

Tumors of plasma cell origin include multiple myeloma (arising primarily from bone marrow) and extramedullary plasmacytomas (usually cutaneous but may be in other sites such as GI).

- Cutaneous plasmacytomas are usually benign. GI tumors are more likely to be malignant.
- Well-differentiated plasmacytomas yield cells that resemble normal plasma cells. Small, round nuclei with deeply basophilic cytoplasm exist with or without the characteristic paranuclear clear zone. Poorly differentiated plasmacytoma cells are less distinct and demonstrate significant criteria of malignancy. Binucleate and multinucleate cells are common in both well and poorly differentiated plasmacytomas. This and a lack of lymphoglandular bodies help differentiate these tumors from lymphosarcoma.

### **Transmissible Venereal Tumor (TVT)**

TVT cells are typically more pleomorphic than other discrete cell tumors.

- Moderate smoky to light blue cytoplasm, numerous cytoplasmic vacuoles that may also be found extracellularly. Nuclei show moderate to marked anisokaryosis and have coarse nuclear chromatin. Nucleoli may be prominent, and mitotic figures are common.

### **Melanoma**

Great imitators, cells show features of discrete cells, epithelial cells, or mesenchymal cells. Usually easily recognized due to their pigment. Individual melanin granules are rod-shaped and stain dark green to black. Cells may be heavily to sparsely pigmented.

- Poorly differentiated melanomas may have sparse pigmentation and show marked criteria of malignancy.

## Cytologic Features of Mesenchymal Cells

- Mesenchymal cells are cells that form connective tissue, blood vessels, and lymphatics.
- Hematopoietic cells are classified as mesenchymal cells, but because their appearance is so distinct, they are typically considered a separate classification. Usually, discussion of mesenchymal cells implies stromal connective tissue cells.
- Cytoplasmic borders are often indistinct.
- Most connective tissues exfoliate no cells when sampled by fine needle aspiration. May see fibroblasts or fibrocytes on occasion. Reactive fibroblast may be seen in aspirates of inflamed tissue or tissues undergoing tissue repair. Reactive fibroblasts may show many criteria of malignancy, but reactive fibroblasts should be suspected when seen within a population of inflammatory cells.
- Highly cellular smears that contain predominately a pure population of mesenchymal cells are likely to indicate a mesenchymal neoplasm (sarcoma).
- Mesenchymal cells are often elongated with cytoplasm that tapers in one or more directions (referred to as *spindle cells*).
- May see elongated cells with rod-shaped nuclei to plump, minimally tapered cells with round nuclei. Neoplastic mesenchymal cell tumors may show features more consistent with epithelial or discrete cells.

## Cytologic Features of Normal Epithelial Cells

- Cell-to-cell adhesion
- Although normal epithelial cells can be small to large, they can be very large and have abundant cytoplasm.
- Round to columnar to caudate in shape and have sharply defined cytoplasmic borders.
- Nuclei generally are round to oval.
- Squamous epithelial cells tend to be more individually oriented when collected by surface swabs or scrapings. As they mature, their nuclei become small and pyknotic, and eventually the cell becomes anucleate.
- Respiratory and GI cells are distinctly columnar. May show long rows of cells with nuclei lined up at the basal end. Cilia may be seen at the apical end of respiratory epithelial cells.
- Glandular epithelial cells may show evidence of tubular or acinar formation.
- Tumors of epithelial cell origin may retain characteristic features.

# Cytology of Ear Canal Swabs

## Bacteria

- Ear canals normally contain small amounts of bacteria.
- With bacterial otitis, large numbers of bacteria are seen free in the smear.
- Neutrophilic inflammation is sometimes seen, especially with concurrent otitis media.
- Visualization of cocci on the smear often represents *Staphylococcus* but may also be *Enterococcus* or *Streptococcus*.
- Rods most commonly indicate *Pseudomonas* followed by *Proteus* and *Escherichia coli*.

## Fungi

- *Malassezia pachydermatis* is by far the most common yeast seen on ear cytologies but may be found in smaller numbers in normal ears.
- May see concurrent bacteria and yeast infection
- Yeasts overgrow when the environment is favorable.
- Rarely see *Candida* and *Microsporum*

## Mites

- *Otodectes cynotis* common primary cause of otitis (50% of cats, 5% of dogs)
- *Demodex canis* and *D. cati*, *Sarcoptes scabiei*, and *Notoedres cati* are infrequently seen in ear canals.
- Mites tend to wash off slides during staining. Unstained slides of ear secretions or swabs rolled in mineral oil may be better for finding mites in the ear canal. Skin scrapings of the ear pinna are best for finding *Demodex*, *Sarcoptes*, or *Notoedres*.

## Neoplasia

- The most common benign tumors seen in the ear canal are polyps, papillomas, basal cell tumors, and ceruminous gland adenomas.
- The most common malignant tumors are ceruminous gland adenocarcinomas, squamous cell carcinomas, and other carcinomas.
- Unfortunately, neoplastic cells are rarely seen on ear cytologies.
- May only see cytologic evidence of inflammation
- Fine-needle aspiration or biopsy of otic masses is usually necessary to establish a diagnosis.

## Miscellaneous

- Ceruminous otitis externa is associated with seborrheic conditions.
- Oily, yellow discharge may resemble purulent exudate, but cytology is relatively devoid of inflammatory cells.

# Cytology of Nasal Swabs or Flush Specimens

## Normal Findings

- *Simonsiella* spp.—large, stacked, rod-shaped bacteria, normal inhabitants of the oral cavity
- Nonkeratinized squamous epithelial cells, often with adherent bacteria, are obtained from the external nares and oropharynx.
- Ciliated pseudostratified columnar epithelial cells and mucus from nasal turbinates
- Basal epithelial cells are smaller and rounded and have dark blue cytoplasm.
- May see red blood cells from hemorrhage secondary to sampling

## Infectious Agents

- Neutrophils predominate with bacterial, viral, or fungal infections.
- May also see macrophages, lymphocytes, and plasma cells
- Bacterial infection suspected when bacteria seen within neutrophils
- Because bacteria from the oral cavity are usually a pleomorphic population, monomorphic populations suggest infection.
- Bacterial infection of the nasal cavity usually is secondary to trauma, foreign bodies, viral or fungal infection, neoplasia, or oronasal fistulas.
- Intranuclear viral inclusions may be seen in epithelial nuclei with herpes infections in cats.
- Fungal hyphae may be present, may need special stains to identify. Nasal cavity fungi include *Aspergillus* spp., *Penicillium* spp., *Cryptococcus neoformans*, *Rhinosporidium* spp.
- Nasal mites (*Pneumonyssus caninum*, *Linguatula serrata*). *Capillaria aerophila* may be found in nasal sinuses.

## Noninfectious Conditions

- Foreign bodies often consist of inhaled plant material (grass awns or foxtails).
- May lead to chronic rhinitis
- Exudates with eosinophils may be seen with inhaled allergens.
- Neoplasia of the nasal cavity is usually seen in older patients.
- Epithelial, mesenchymal tumors of nasal cavity cells, extension of oral neoplasms, or transplanted from other sites (e.g., TVT)
- Most nasal tumors are epithelial in origin. Adenocarcinomas most common, followed by squamous cell carcinomas and undifferentiated carcinomas
- Mesenchymal tumors of the nasal cavity include fibrosarcomas, chondrosarcomas, osteosarcomas, hemangiosarcomas, and undifferentiated sarcomas. Do not exfoliate readily
- Round cell tumors of the nasal cavity include transmissible venereal tumors, lymphosarcomas, and mast cell tumors.



## Dexamethasone Suppression Tests

### Low-Dose Dexamethasone Suppression Test (LDDST)

#### **Normal**

Four-hour cortisol level suppresses to less than 50% of baseline cortisol (usually  $< 1.4 \mu\text{g/dL}$ ), and then 8-hour cortisol remains at or near that level.

#### **Pituitary-dependent hyperadrenocorticism (PDH):**

Four-hour cortisol level is suppressed to less than 50% of baseline (60% of dogs) or less than  $1.4 \mu\text{g/dL}$  (25% of dogs) and an 8-hour cortisol level of less than 50% of baseline but  $1.4 \mu\text{g/dL}$  or greater (25% of dogs).

Dexamethasone resistance, in which none of the previous criteria is met, occurs in 40% of PDH cases.

#### **Functional adrenal tumor (FAT):**

Dexamethasone administration has no effect on cortisol levels.

### High-Dose Dexamethasone Suppression Test

Differentiates PDH from FAT in cases where none of the criteria for PDH is met with the LDDST

#### **FAT:**

8-hour cortisol level—no suppression of cortisol levels with dexamethasone administration

#### **PDH:**

8-hour cortisol level is less than 50% of baseline cortisol or less than  $1.4 \mu\text{g/dL}$ .

## **Disseminated Intravascular Coagulation (DIC), Diagnostic Tests**

### **Fibrinogen:**

increased

### **Activated partial thromboplastin time (APTT):**

prolonged

### **Prothrombin time (PT):**

prolonged

### **Platelet count:**

decreased

### **Fibrin degradation products (assays for breakdown of fibrin clots):**

increased

### **d-Dimer (assays for proteolytic fragment of fibrinogen degradation):**

increased

### **Note:**

d-Dimer has a high negative predictive value. A negative test reliably rules out DIC.

## Eosinophil Count

## Normal range:

Feline: 0-1000 cells/ $\mu$ L

Canine: 0-1200 cells/ $\mu$ L

## Eosinophils:

### Elevated (eosinophilia) in:

parasitic disorders (hookworm, dirofilariasis, dipetalonemiasis, fleas, filaroides, aelurostrongylus, roundworms, paragonimiasis, *Cuterebra*); hypersensitivity (flea allergy dermatitis, atopy, food allergy); eosinophilic infiltrative disease (eosinophilic granuloma complex, feline bronchial asthma, eosinophilic gastroenteritis/colitis, pulmonary infiltrates with eosinophils [dogs], hypereosinophilic syndrome); infectious diseases (toxoplasmosis, suppurative processes); neoplasia (eosinophilic leukemia, mast cell neoplasia, lymphoma, myeloproliferative disorders, solid tumors), hypoadrenocorticism, pregnancy

### Decreased (eosinopenia) in:

stress, hyperadrenocorticism, glucocorticoid therapy

## Erythrocyte Count (RBC Count)

## Normal range:

Feline: 5.92-9.93  $10^6/\mu\text{L}$

Canine: 4.8-9.3  $10^6/\mu\text{L}$

## Elevated in:

dehydration, splenic contraction, polycythemia

## Decreased in:

Regenerative anemias

- Acute and chronic hemorrhage

  - GI hemorrhage

  - Ulcer disease

  - Neoplasia

- Trauma

- Coagulopathies

- Ectoparasites (fleas, ticks)

- Endoparasites (hookworms, Coccidia)

- Hematuria

Hemolytic anemia

- Immune mediated

- Cold hemagglutinin disease

- Oxidant injury (onion, kale, phenothiazines, methylene blue)

- Parasitic

  - Babesiosis

  - Haemobartonella felis* (*Mycoplasma haemofelis*)

  - Haemobartonella canis* (*Mycoplasma haemocanis*)

  - Cytauxzoon felis*

- Infectious

  - Leptospirosis

  - E. coli*

- Microangiopathic

  - Dirofilariasis

  - Vascular neoplasia

  - Vasculitis

  - DIC

- Zinc or copper toxicosis

- Hypophosphatemia

- Pyruvate kinase deficiency

- Phosphofructokinase deficiency

Nonregenerative anemias

- Renal failure

- Anemia of chronic disease

  - Inflammatory disease

  - Infectious disease

  - Neoplasia

- Drugs

  - Chemotherapeutics

  - Chloramphenicol

  - Sulfadiazine

  - Phenylbutazone

- Iron deficiency

  - Chronic blood loss

  - Nutritional

- Endocrine disease
  - Hypothyroidism
  - Hypoadrenocorticism
  - Hyperestrogenism
    - Diethylstilbestrol
    - Estradiol
  - Sertoli cell tumor
- Infectious
  - Feline leukemia virus (FeLV)
  - Feline immunodeficiency virus (FIV)
  - Ehrlichiosis
  - Feline panleukopenia virus
- Idiopathic aplastic anemia
- Red cell aplasia
- Myeloproliferative disease
- Myelophthisis
- Hypersplenism
- Lead poisoning
- Leukemias



## Folate

## **Normal range:**

Feline: 9.7-21.6 ng/mL

Canine: 7.7-24.4 ng/mL

Usually performed in conjunction with serum cobalamin and trypsinlike immunoreactivity

## **Elevated in:**

exocrine pancreatic insufficiency, small intestinal bacterial overgrowth, dietary supplementation

## **Decreased in:**

small intestinal mucosal disease, antibiotics depleting intestinal flora

## Fructosamine

## **Normal range:**

Feline and canine: 175-400  $\mu\text{mol/L}$

Single sample test that assays mean blood glucose over the previous 1-3 weeks

## **Elevated:**

> 500  $\mu\text{mol/L}$ : indicates poor glycemic control (hyperglycemia)

## **Declining or within normal range:**

indicates improving or adequate glycemic control

## **Decreased to below lower end of reference range (< 300 $\mu\text{mol/L}$ ):**

suggests that patient has experienced significant periods of hypoglycemia over past 1-3 weeks, also hypoalbuminemia/hypoproteinemia may falsely lower fructosamine

## **Values within normal range with PU/PD and polyphagia:**

suggestive of Somogyi phenomenon

## **Note:**

Fructosamine values should not be used to make specific adjustments in insulin dosage.

## **Gamma Glutamyltransferase (GGT)**

## Normal range:

Feline: 1-4U/L  
Canine: 1-6 U/L

## Elevated:

cholestasis—GGT mirrors alkaline phosphatase (intrahepatic, extrahepatic), drugs (dogs [glucocorticoids]), anticonvulsants (phenobarbital, primidone), hepatocellular disease (generally slight increase)

## Note:

Cats with hepatic lipidosis tend to have normal to mildly elevated GGT but greatly elevated alkaline phosphatase levels.

## Decreased:

spurious (e.g., laboratory error, lipemic sample), hemolysis

## Globulin

## Normal range:

Feline: 2.3-5.3 g/dL

Canine: 1.6-3.6 g/dL

## Elevated in:

dehydration (albumin and total protein also elevated); infection (polyclonal gammopathy; chronic pyoderma, pyometra, chronic periodontitis, FIP, bacterial endocarditis, brucellosis, FIV, FeLV, ehrlichiosis [may cause polyclonal or monoclonal gammopathy], leishmaniasis [may cause polyclonal or monoclonal gammopathy], systemic mycoses, chronic pneumonia, bartonellosis, *Mycoplasma haemofelis* infection, Chagas disease, babesiosis); immune-mediated disease (polyclonal gammopathy); neoplasia (polyclonal gammopathy [necrotic or draining tumors, lymphomas, mast cell tumors]); neoplasia (monoclonal gammopathy [multiple myeloma, chronic lymphocytic leukemia, lymphoma]); cutaneous amyloidosis; "idiopathic" monoclonal gammopathy



## Glucose

## Normal range:

Feline: 64-170 mg/dL

Canine: 70-138 mg/dL

## Elevated (hyperglycemia) in:

diabetes mellitus, stress (cats), hyperadrenocorticism, pancreatitis, drugs (glucocorticoids, progestagens, megestrol acetate, thiazide diuretics), parenteral nutrition, dextrose-containing fluids, postprandial, acromegaly (cats), diestrus (bitch), pheochromocytoma (dogs), exocrine pancreatic neoplasia, renal insufficiency, head trauma

## Decreased (hypoglycemia) in:

hepatic insufficiency (portal caval shunts, chronic fibrosis, cirrhosis); sepsis; prolonged sample storage; iatrogenic (insulin therapy, sulfonylurea therapy); toxicity (ethanol ingestion, ethylene glycol);  $\beta$ -cell tumor (insulinoma); extrapancreatic neoplasia (hepatocellular carcinoma or hepatoma, leiomyosarcoma or leiomyoma, hemangiosarcoma, carcinoma [mammary, salivary, pulmonary], leukemia, plasmacytoma, melanoma); hypoadrenocorticism; hypopituitarism; idiopathic hypoglycemia (neonatal hypoglycemia, juvenile hypoglycemia [toy breeds], hunting dog hypoglycemia); renal failure; exocrine pancreatic neoplasia; glycogen storage diseases; severe polycythemia; prolonged starvation; laboratory error

## Glucose Tolerance Test

May be used to differentiate type 1 (insulin dependent) from type 2 (non-insulin dependent) diabetes mellitus in cats (all dogs are considered to have type 1); results inconsistent; not usually done

## Glycosylated Hemoglobin

Assays measure mean blood glucose over the life span of erythrocytes (3-4 months); in dogs, values between 4% and 6% are associated with adequate glycemic control; used less often than fructosamine

## Heartworm Antibody, Feline

Should be interpreted in conjunction with a feline heartworm antigen test

Should be interpreted in light of clinical, clinicopathologic, and radiographic signs

A negative test suggests no exposure to *Dirofilaria immitis* and helps to rule out.

A positive test supports prior exposure but does not confirm active infection.

## Heartworm Antigen, Canine

A negative test implies no infection.

A positive test supports active infection.

A sample hemolysis may cause a false-positive result.

A low worm burden may cause a false-negative result.

The result may remain positive for up to 16 weeks after successful adulticide therapy.

## Heartworm Antigen, Feline

Should be interpreted in conjunction with a feline heartworm antibody test

Negative test is not useful; may still be positive

Positive test is highly specific; infection is likely

Should be interpreted in light of clinical, clinicopathologic, and radiographic signs

Sample hemolysis may cause false-positive result

Low worm burden or male unisexual infection will cause false-negative result

## Hematocrit (PCV)



## Normal range:

Feline: 29%-48%

Canine: 36%-60%

## Increased in:

dehydration (total protein also increased), polycythemia, splenic contracture

## Decreased in:

anemia (for more detailed list, *see* Erythrocyte Count); color of plasma in spun-down hematocrit tube can help determine if icterus (yellow) or intravascular hemolysis (red) is present; buffy coat: may see microfilaria if patient has heartworm disease; mast cells in systemic mastocytosis

## Hemoglobin

Hemoglobin concentrations are usually proportional to hematocrit except in rare cases where hemoglobin synthesis defects stimulate polycythemia.

## Hemolysis, Prevention in Laboratory Samples

### Steps to Prevent Hemolysis:

Fasted patient: lipemia increases red cell fragility.

Minimize negative pressure (may cause vein to flutter against needle, crushing red cells).

Reposition needle deeper, or slightly rotate to move bevel of needle away from vessel wall.

Resist tendency to increase vacuum by using more negative force; “milk” the vein.

Use vacuum tubes and needles instead of syringes.

Remove needle and specimen tube stopper, and transfer sample directly into open tube.

Aspirate small amount of air from tube to reestablish negative pressure to prevent tops from coming off in transit.

## Immunoassays

**Assays that detect all immunoglobulins to a specific antigen in a serum sample:**

Complement fixation

Hemagglutination inhibition

Serum neutralization

Agglutination assay

Agar gel immunodiffusion

Indirect fluorescent antibody

**Assays that may be used to detect specific immunoglobulins (IgG, IgM, IgA) to antigens in a serum sample:**

Enzyme-linked immunosorbent assay (ELISA)

Western blot immunoassay

IgM usually first immunoglobulin produced; may indicate recent infection and more likely to be active infection rather than just previous exposure.

Production of immunoglobulin shifts to IgG and/or IgA in days to weeks; indicates more chronic infection and possibly exposure without active disease.

Demonstrating a rising titer with paired samples may be necessary to document active infection.

## Insulin

## **Normal range:**

Feline and canine: 15-35  $\mu$ IU/mL

## **Elevated:**

normal or elevated insulin concentration in the presence of hypoglycemia is supportive of insulinoma (pancreatic islet beta-cell neoplasia). Also may be elevated with insulin therapy or leiomyosarcoma

## **Decreased:**

decreased insulin levels are not a reliable indicator of diabetes mellitus. Patients with insulin-dependent diabetes mellitus (IDDM) should have low insulin and high glucose levels. Insulin levels in non-insulin-dependent diabetes mellitus (NIDDM) are variable.

## Iron-Binding Capacity (Total, TIBC)/Ferritin

### **Decreased TIBC and decreased ferritin:**

chronic (not acute) blood loss (intestinal ulceration, hookworm anemia, bleeding from neoplasia, etc.)

### **TIBC normal to increased, ferritin decreased:**

iron deficiency

### **TIBC normal to low, ferritin normal to high:**

anemia of chronic inflammatory disease

## **Joint Fluid (Arthrocentesis)**

### **Gross appearance:**

Evaluate for turbidity (cloudiness), viscosity (does it form a long string when allowed to drip from a needle?), and color (clear, red or hemorrhagic, yellow); yellow color (xanthochromia) may indicate previous hemorrhage, degenerative, traumatic, or inflammatory disease.

### **Gross appearance, microscopic examination/cytologic evaluation**



## Normal

Straw-colored, clear, viscous, firm mucin clot test

1-3 mononuclear cells per high-power field (hpf)

Large and small mononuclear cells with numerous vacuoles and granules; less than 10% are neutrophils (< 1 neutrophil/500 erythrocytes if blood contamination has occurred).

## Hemarthrosis

Bloody or xanthochromic, turbid, reduced viscosity, normal to slightly friable mucin clot test

Hemosiderin-laden macrophage, erythrophagia, moderate neutrophils

## Chronic degenerative joint disease

Light yellow, clear to slightly turbid, viscous, normal firm mucin clot

0%-20% neutrophils, few to moderate lymphocytes and macrophages

## **Immune-mediated joint disease (nonerosive)**

Yellow to blood-tinged, slight to moderate turbidity, reduced viscosity, friable mucin clot test  
15%-95% neutrophils, few to moderate lymphocytes, synoviocytes, macrophages

### **Traumatic**

Straw-colored to blood-tinged, slight to moderate turbidity, normal to slightly turbid, normal to slightly friable mucin clot test  
Variable neutrophils  
May see hemorrhage

### **Septic**

Yellow to blood-tinged to bloody, turbid to purulent, reduced viscosity, friable mucin clot test  
90%-99% neutrophils  
May see microorganisms within cells  
Toxic changes in neutrophils

### **Rheumatoid arthritis (erosive)**

Yellow to blood-tinged, turbid, reduced viscosity, friable mucin clot test  
20%-80% neutrophils  
SLE-induced polyarthritis: may see LE cells

## Lactate

## Normal range:

Feline: 0.5-2.0 mmol/L

Canine: 0.3-2.5 mmol/L

## Causes of Lactic Acidosis in Veterinary Medicine

### Type A (mechanism: tissue hypoxia or hypoperfusion)

- Decreased O<sub>2</sub> delivery
  1. Anemia
  2. Shock (cardiogenic, septic, hypovolemic)
  3. Regional hypoperfusion
  4. Global hypoperfusion
  5. Carbon monoxide intoxication
- Increased O<sub>2</sub> demand
  1. Exercise
  2. Seizures
  3. Uncontrolled shivering

### Type B1 (mechanism: decreased lactate clearance)

- Hepatic disease
- Diabetes mellitus
- Sepsis, systemic inflammatory response syndrome (SIRS)
- Renal failure
- Hyperthyroidism
- Neoplasia
- Alkalosis

### Type B2 (mechanism: drugs or toxins that interfere with oxidative phosphorylation)

- Ethylene glycol
- Propylene glycol
- Catecholamines
- Carbon monoxide
- Bicarbonate
- Salicylates
- Acetaminophen
- Others (cyanide, strychnine, nitroprusside, halothane, terbutaline, activated charcoal)

### Type B3 (mechanism: mitochondrial defects)

- Mitochondrial myopathies (inborn and acquired)

### D-lactic acidosis (mechanism: production of D-lactate from bacterial glucose metabolism or alternative metabolic pathways)

- Diabetes mellitus
- Small intestinal bacterial overgrowth
- Exocrine pancreatic insufficiency
- Propylene glycol toxicosis

## Lipase

## Normal range:

Feline: 10-450 U/L

Canine: 77-695 U/L

## Elevated in:

most often seen with acute pancreatitis, pancreatic necrosis, pancreatic neoplasia, enteritis, renal disease, hepatic disease, glucocorticoids; rarely elevated with certain neoplasms in the absence of pancreatitis

## Note:

Not very sensitive or specific for pancreatic disease

## Lymphocyte Count

## **Normal range:**

Feline: 1200-8000 cells/ $\mu$ L

Canine: 690-4500 cells/ $\mu$ L

## **Elevated (lymphocytosis):**

physiologic or epinephrine induced, postvaccination, leukemia (lymphocytic, lymphoblastic), chronic antigenic stimulation (e.g., chronic infection, viremia, immune-mediated, inflammatory bowel disease, cholangiohepatitis, ehrlichiosis, Chagas disease, babesiosis, leishmaniasis, hypoadrenocorticism)

## **Decreased (lymphopenia):**

corticosteroid or stress induced; chemotherapy; immunodeficiency (FeLV, FIV); loss of lymph (chylothorax, lymphangiectasia); viral disease (FeLV/FIV, FIP, parvovirus, canine distemper, canine infectious hepatitis)



## Magnesium (Mg)

## Normal range:

Feline: 1.1-2.3 mEq/L

Canine: 1.2-1.9 mEq/L

## Increased in:

renal failure or insufficiency, excessive oral intake (antacids, laxatives), excessive parenteral administration

## Decreased:

dietary, GI (malabsorption, chronic diarrhea, pancreatitis, cholestatic liver disease), renal (glomerular disease, tubular disease, postobstructive diuresis, prolonged intravenous fluids, diuretics, digitalis administration, hypercalcemia, hypokalemia), endocrine (diabetic ketoacidosis, hyperthyroidism, primary hyperparathyroidism, primary hyperaldosteronism), multiple endocrine disorders, sepsis, blood transfusion, parenteral nutrition, hypothermia, dialysis, drugs (diuretics, amphotericin B, insulin, glucose, amino acids)

## Mean Corpuscular Volume (MCV)

## **Normal range:**

Feline: 37-61 fL  
Canine: 58-79 fL

## **Elevated (macrocytosis) in:**

regeneration, FeLV, FIV, breed-related characteristics (Poodles), dyserythropoiesis (bone marrow disease), sample artifact (swelling of RBCs secondary to prolonged storage in EDTA tubes)

## **Decreased (microcytosis) in:**

iron deficiency, portosystemic shunt, polycythemia, breed-related characteristics (Akita, Shar-Pei, Shiba Inu)

## Methemoglobinemia

Methemoglobin is the form of hemoglobin in which the heme iron has been oxidized from ferrous ( $\text{Fe}^{2+}$ ) to ferric ( $\text{Fe}^{3+}$ ) and is rendered unable to bind and transport oxygen.

Methemoglobinemia is seen in oxidative damage-induced hemolytic anemias and with rare inherited erythrocyte disorders.

## **Methods of Sample Collection for Cytology**

### **Fine-Needle Biopsy (Aspiration or Nonaspiration Method)**

- Surface masses
- Internal masses
- Lymph nodes
- Internal organs
- Fluid collection

### **Impression Smear**

- Exudative cutaneous lesions
- Preparation of cytology samples from biopsy specimens

### **Scraping**

- Flat cutaneous lesions not amenable to fine-needle biopsy
- Preparation of cytologic samples from poorly exfoliative biopsy specimens

### **Swab**

- Vaginal smears
- Fistulous tracts
- Otic swabs
- Nasal, conjunctival swabs

## Monocyte Count

## Normal range:

Feline: 0-600 cells/ $\mu$ L

Canine: 0-840 cells/ $\mu$ L

## Elevated (monocytosis) in:

infection (pyometra, abscess, peritonitis, pyothorax, osteomyelitis, prostatitis, *Mycoplasma haemofelis*, blastomycosis, histoplasmosis, *Cryptococcus*, *Coccidioides*, heartworm disease, other bacteria [e.g., nocardiosis, actinomycosis, mycobacteriosis]); stress or corticosteroid induced; immune-mediated disease (hemolytic anemia, dermatitis, polyarthritis); trauma with severe crushing injury; hemorrhage into tissues or body cavities; neoplasia (tumor necrosis, lymphoma, myelodysplastic disorders, leukemias, myelomonocytic leukemia, monocytic leukemia, myelogenous leukemia, hemophagic histiocytic sarcoma)



## **Myoglobinuria**

Brown to dark-red urine with an absence of RBCs in urine sediment and a positive test for occult blood; seen with generalized muscle disease

## Neutrophil Count

## Normal range:

Feline: 2500-8500 cells/ $\mu$ L

Canine: 2060-10600 cells/ $\mu$ L

## Elevated (neutrophilia):

increased production (infection [bacterial, systemic mycoses, protozoal], inflammation [immune-mediated disease, neoplasia, tissue trauma, tissue necrosis]); demargination (stress, hyperadrenocorticism, glucocorticoids); metabolic (uremia, diabetic ketoacidosis); associated with regenerative anemia (hemolytic anemia, hemorrhagic anemia); chronic granulocytic leukemia

## Decreased (neutropenia):

decreased production (myelophthisis [myeloproliferative disease, lymphoproliferative disease, metastatic neoplasia], myelofibrosis, drug induced [chemotherapeutics, griseofulvin, chloramphenicol, trimethoprim-sulfa, azathioprine, estrogen, phenylbutazone, phenobarbital], infectious [parvovirus, ehrlichiosis, FIV, FeLV {aplastic anemia, myelodysplasia, panleukopenia-like syndrome}], hypersplenism, idiopathic hypoplasia/aplasia [cyclic neutropenia, immune mediated]); increased consumption (bacteremia/septicemia, severe systemic infection, endotoxemia); hypoadrenocorticism; margination

## Osmolality

Plasma osmolality is expected to be decreased in primary polydipsia (psychogenic polydipsia); diabetic ketoacidosis; azotemia; hypernatremia; hyperglycemia; and intoxication with ethylene glycol, ethanol, or methanol.

Plasma osmolality is expected to be increased in primary polyuria (DI).

There may be considerable overlap in values of primary polyuria and polydipsia. However, osmolality of less than 280 mOsm/kg suggests psychogenic polydipsia, whereas osmolality of greater than 280 mOsm/kg suggests central DI, nephrogenic DI, or psychogenic polydipsia.

## Packed Cell Volume

See [Hematocrit](#).

## **Parathyroid Hormone (PTH)/Ionized Calcium**

## Normal range:

### PTH:

Feline: 0.0-40.0 pg/mL

Canine: 20.0-130.0 pg/mL

### Ionized Calcium:

Feline: 1.16-1.34 mmol/L

Canine: 1.24-1.43 mmol/L

## Elevated in:

primary hyperparathyroidism (elevated ionized calcium and mid-to-high elevated PTH), renal or nutritional secondary hyperparathyroidism (normal or decreased ionized calcium and elevated PTH), hypercalcemia of malignancy, vitamin D toxicity, granulomatous inflammatory disease

## Decreased in:

primary hypoparathyroidism (decreased ionized calcium and low or low-normal PTH)

## Phosphorus (P)



## Normal range:

Feline: 2.4-8.2 mg/dL

Canine: 2.5-6.0 mg/dL

## Elevated in:

young, growing animal (also see elevated alkaline phosphatase); reduced glomerular filtration rate (GFR, acute renal failure [ARF], chronic renal failure); postrenal obstruction, primary hypoparathyroidism, nutritional secondary hyperparathyroidism, hyperthyroidism, acromegaly, hemolysis, intoxication (hypervitaminosis D, jasmine ingestion); hypoparathyroidism; dietary excess; metabolic acidosis; iatrogenic (phosphate enemas, parenteral administration); osteolysis; osteolytic neoplasia; rhabdomyolysis; tumor cell lysis syndrome; sample hemolysis/delayed serum separation

## Decreased in:

primary hyperparathyroidism (also see increased calcium); nutritional secondary hyperparathyroidism; renal tubular acidosis; vomiting/diarrhea; neoplasia (PTH-like hormone, C-cell thyroid tumors); insulin therapy; diabetic ketoacidosis; Fanconi syndrome; dietary deficiency; decrease intestinal absorption; eclampsia; hyperadrenocorticism; vitamin D deficiency; hyperaldosteronism; aggressive fluid therapy; bicarbonate administration; respiratory or metabolic acidosis

## Platelet Count

## Normal range:

Feline: 200-500  $10^3/\mu\text{L}$

Canine: 170-400  $10^3/\mu\text{L}$

## Elevated in:

essential thrombocytosis, rebound thrombocytosis, polycythemia vera

## Decreased (see p. 174):

decreased production (infectious [retroviruses: FIV, FeLV; *Ehrlichia*]); increased destruction (immune-mediated thrombocytopenia); sequestration (hypersplenism); increased consumption (hemorrhage, DIC); breed idiosyncrasy (King Charles Spaniels [macrothrombocytes], Greyhounds)

## Polymerase Chain Reaction

- PCR amplifies small quantities of DNA to detectable levels.
- Can also be used to detect RNA with a reverse transcriptase step (RT-PCR)
- In general PCR is more sensitive than cytologic, serologic, or histopathologic techniques and is comparable to culture.
- PCR is of great benefit for demonstration of infectious agents, especially if the organism is difficult to culture or cannot be cultured.
- Specificity can be quite high depending on the primers used in the reaction. For example, primers can be designed to detect one bacterial genus but not others. Primers can also be designed to identify one species (e.g., all *Ehrlichia* spp. or only *E. canis*).
- False-positive if sample is contaminated during collection or in laboratory.
- False-negative if sample is handled inappropriately.

## Potassium (K)

## Normal range:

Feline: 3.4-5.6 g/dL

Canine: 3.6-5.5 g/dL

## Elevated in:

renal failure (distal renal tubular acidosis, oliguric/anuric); postrenal (obstruction, ruptured bladder); hypoadrenocorticism; acidosis (diabetic ketoacidosis); GI (trichuriasis, salmonellosis, perforated duodenal ulcer); chylothorax with repeated pleural fluid drainage; massive muscle trauma; postischemic reperfusion; dehydration; hypoaldosteronism; drugs (potassium-sparing diuretics, angiotensin-converting enzyme [ACE] inhibitors, propranolol); thrombocytosis; severe leukocytosis ( $> 100,000/\mu\text{l}$ ); hemolysis in breed with high RBC potassium concentration (Akita, English Springer Spaniel, neonates, individuals); hyperkalemic periodic paralysis

## Decreased in:

alkalosis; dietary deficiency (feline); potassium-free fluids; bicarbonate administration; drugs (penicillins, amphotericin B, loop diuretics, thiazide diuretics); GI fluid loss (vomiting and diarrhea, potassium rich); hyperadrenocorticism; hyperaldosteronism; insulin therapy; diuresis caused by diabetic ketoacidosis; renal (postobstructive diuresis, renal tubular acidosis, dialysis); hypokalemic periodic paralysis (Burmese cat, Pit Bull Terrier); renal failure (chronic polyuria); total parenteral nutrition; hypokalemic periodic paralysis (Burmese cats)

## Protein, Total (TP)

## **Normal range:**

Feline: 5.2-8.8 g/dL

Canine: 5.0-7.4 g/dL

## **Elevated in:**

dehydration (albumin and globulin increased); hyperglobulinemia (chronic inflammation, infection, neoplasia [e.g., multiple myeloma]); spurious (hemolysis, lipemia)

## **Decreased in:**

hemorrhage, hypoalbuminemia, liver failure, external plasma loss, GI fluid loss, malassimilation, starvation, overhydration, glomerular loss, tumor cachexia



## Prothrombin Time (PT)

## Normal range:

Feline: 6-11 seconds

Canine: 6-12 seconds

Determines abnormalities in the extrinsic coagulation pathway

Prolonged with deficiencies of factors II, VII, and X

Becomes prolonged before any changes seen in activated coagulation time (ACT) or activated partial thromboplastin time (APTT)

Prolonged with DIC, acquired vitamin K deficiency (rodenticide poisoning), bile insufficiency, and liver failure

## Red Blood Cell (RBC) Count

See [Erythrocyte Count](#).

## Reticulocyte Count

Elevated reticulocyte count is the best indicator of effective erythropoiesis.

*Step 1:* Multiply percent reticulocytes by red cell count to determine absolute quantity.

*Step 2:* Correct for reduced red cell mass; multiply absolute reticulocytes by patient's hematocrit divided by mean species hematocrit to obtain the number of reticulocytes per milliliter.

*Step 3:* Correct for the effect of erythropoietin on the bone marrow reticulocyte release; divide the number of reticulocytes per milliliter by average number of days that a reticulocyte circulates in peripheral blood at that patient's hematocrit to obtain a corrected absolute reticulocyte count.

A corrected absolute reticulocyte count of less than 105,000/mL is indicative of a nonregenerative anemia, whereas strongly regenerative anemias will have a reticulocyte count of greater than 150,000/mL.

## Sodium (Na)

## Normal range:

Feline: 145-158 mEq/L

Canine: 139-154 mEq/L

## Elevated in:

dehydration; renal failure; GI fluid loss ( $\text{Na}^+$  poor) (vomiting, diarrhea); insensible fluid loss (panting, high ambient temperature, fever); third space loss (i.e., pancreatitis, peritonitis); cutaneous loss (e.g., burns); decreased water intake (limited access to water, primary adipsia); hyperaldosteronemia; increased salt intake (oral, intravenous); spurious (evaporation of serum sample)

## Decreased in:

hypoadrenocorticism; GI fluid loss ( $\text{Na}^+$  rich) (vomiting, diarrhea); severe liver disease; hookworms; renal failure (polyuric); nephrotic syndrome causing effusion; chronic effusions; diuretics; hypotonic fluids; diabetes mellitus; mannitol infusion; burns; excess antidiuretic hormone (ADH); diet (severe sodium restriction); antidiuretic drugs (e.g., vincristine, cyclophosphamide, nonsteroidal antiinflammatory drugs [NSAIDs]); myxedema coma of hypothyroidism; psychogenic polydipsia; spurious (hyperlipidemia, marked hyperproteinemia)

## **Symmetric Dimethylarginine (SDMA) Assay**

SDMA (symmetric dimethylarginine) is a renal biomarker specific to kidney function. SDMA increases with as little as 25% loss of kidney function, making it more reliable in both acute or active kidney injury and chronic kidney disease. Creatinine cannot identify kidney issues until almost 75% of kidney function is lost.

## **Normal range:**

Feline 0-14 µg/dL

Canine 0-14 µg/dL (0-16 µg/dL in puppies)

## **Elevated in:**

impaired glomerular filtration (prerenal, renal, and postrenal causes)



## Thoracocentesis Fluid

### Pyothorax (septic)

Extremely high nucleated cell counts ( $> 50,000/\mu\text{L}$ ), protein  $> 3.0 \text{ g/dL}$

Primarily degenerate neutrophils and macrophages

Bacteria seen in WBCs

Penetrating wounds, foreign body (grass awns), extension of bacterial pneumonia or discospondylitis, postoperative infection

### Nonseptic

Moderate nucleated cell counts ( $> 5000/\mu\text{L}$ )

Neutrophils, macrophages, eosinophils, lymphocytes

FIP, neoplasia, diaphragmatic hernia, lung lobe torsion

### Chylous Effusion

Low to moderate nucleated cell counts ( $400\text{-}10,000/\mu\text{L}$ )

Predominant cell type is small lymphocyte; also neutrophils and macrophages

Triglyceride concentration of pleural fluid is greater than that of serum.

Idiopathic

Congenital

Secondary to neoplasia, trauma, cardiac disease, fungal granuloma, pericardial disease, dirofilariasis, lung lobe torsion, diaphragmatic hernia, pericardial diaphragmatic hernia, vena caval thrombosis

### Hemorrhagic Effusion

Trauma

Coagulopathy

Neoplasia

Lung lobe torsion

Rupture of vessels associated with parasitic infection (*Spirocerca lupi*, *Dirofilaria immitis*)

### Transudates and Modified Transudates

Protein concentrations less than  $2.5\text{-}3.0 \text{ g/dL}$

Low nucleated cell count ( $< 500\text{-}1000/\mu\text{L}$ )

Macrophages, lymphocytes, mesothelial cells

Right-sided heart failure, pericardial disease, hypoalbuminemia, neoplasia, diaphragmatic hernia

### Note:

Neoplastic cells may or may not be present in effusions caused by neoplastic processes.

### Eosinophilic Effusion

$> 10\%$  of leukocytes are eosinophils.

Reported in dogs in association with heartworm disease, systemic mastocytosis, interstitial pneumonia, and disseminated eosinophilic granulomatosis

## Thrombocyte Count

See [Platelet Count](#).

## Thyroid Function Tests

### Total T<sub>4</sub> (thyroxine, tetraiodothyronine):

Measures free T<sub>4</sub> and protein-bound T<sub>4</sub>.

Below-normal values suggest hypothyroidism (dogs).

Above-normal values in cats are likely caused by hyperthyroidism.

Below-normal values are also seen with underlying illness (sick, euthyroid).

### Free T<sub>4</sub> (fT<sub>4</sub>):

Below-normal values suggest hypothyroidism (dogs).

Above-normal values in cats are likely caused by hyperthyroidism.

Not as affected by the suppressive effects of concurrent illness as total T<sub>4</sub>.

Modified equilibrium dialysis assay is not affected by circulating antithyroid hormone antibodies and therefore is the preferred assay for fT<sub>4</sub>.

### Thyroid-stimulating hormone (TSH) concentration:

Must be interpreted in conjunction with serum T<sub>4</sub> and fT<sub>4</sub>

Low value for serum T<sub>4</sub> and fT<sub>4</sub> with a high TSH supports diagnosis of hypothyroidism.

Normal T<sub>4</sub> and fT<sub>4</sub> and normal TSH rule out hypothyroidism.

### TSH and thyroid-releasing hormone (TRH) stimulation tests:

Used to differentiate hypothyroidism from euthyroid sick syndrome

These tests are not typically done because of availability and expense of reagents.

### T<sub>3</sub> (3,5,3'-triiodothyronine) concentration:

Poor indicator of thyroid function in dogs and cats; not recommended

### Tests for lymphocytic thyroiditis:

Autoantibodies to circulating thyroid hormone (T<sub>4</sub> and T<sub>3</sub>) and thyroglobulin (Tg) correlate with lymphocytic thyroiditis.

Tg autoantibodies may be present when T<sub>4</sub> and T<sub>3</sub> are not; therefore testing for Tg autoantibodies is considered the better screening test.

Provides no information about the severity of disease or the extent of thyroid gland involvement

Hypothyroid dogs may be negative, and euthyroid dogs may have Tg autoantibodies.

May be used as a prebreeding screening test in breeding dogs

### T<sub>3</sub> suppression test:

Administration of T<sub>3</sub> to normal cats should suppress pituitary TSH secretion, decreasing the serum T<sub>4</sub> concentration. Administration of T<sub>3</sub> to hyperthyroid cats should have no suppressive effect.

Confirms hyperthyroidism in cats with occult disease

## **Toxoplasmosis Antibody Titer**

Positive titer indicates exposure but not necessarily active infection.

Positive IgM titer greater than 1:256 is consistent with active infection, especially with typical clinical signs. Positive IgM titer with negative IgG titer may indicate recent infection.

Fourfold rise in IgG titer of paired samples 2-3 weeks apart also supports active infection.

## Triglycerides

## Normal range:

Feline: 25-160 mg/dL

Canine: 29-291 mg/dL

## Elevated in:

postprandial, familial triglyceridemia (Miniature Schnauzer, Beagle, other breeds); hyperchylomicronemia of cats (also observed in dogs); lipoprotein lipase deficiency (cat); endocrine disorders (hypothyroidism, hyperadrenocorticism, diabetes mellitus); nephrotic syndrome; pancreatitis; cholestasis; drugs (glucocorticoids, megestrol acetate)

## Decreased in:

not clearly associated with any disease; severe malabsorptive protein-losing enteropathy, hyperthyroidism, chronic hepatopathies

## **Trypsinogen-Like Immunoreactivity (TLI)**

## **Pancreatic Lipase Immunoreactivity (PLI)**



## Normal range:

### TLI:

Feline: 12.0-82.0 µg/L

Canine: 5.7-45.2.0 µg/L

### PLI:

Feline: 0.1-3.5 µg/L

Canine: 0-200 µg/L

Low TLI values (< 2.5 µg/L for dogs and < 8.0 µg/L for cats) are diagnostic for exocrine pancreatic insufficiency; values between 2.5 and 5.0 µg/L for dogs and 8.0 and 12.0 µg/L for cats are considered equivocal, and the assay should be repeated in 1 month.

High values for TLI are supportive of a diagnosis of acute or chronic pancreatitis.

Elevated values for PLI (> 12 µg/L for cats and > 400 µg/L for dogs) are consistent with a diagnosis of pancreatitis.

Patients must be fasted at least 12 hours.

### Note:

These tests are species specific, and samples must be labeled “dog” or “cat” so that the test can be performed correctly.

# Urinalysis

## Appearance

### Color

*Yellow (normal)*: may be dark amber when concentrated and pale to colorless when diluted.

However, color does not always correlate with concentration.

*Red or reddish-brown*: hematuria, hemoglobinuria, myoglobinuria

*Dark brown or black*: methemoglobinuria

*Yellow-brown to yellow-green*: concentrated sample, bilirubinuria, *Pseudomonas* infection

*Orange*: bilirubinuria

### Turbidity

Normally clear; cloudy urine may contain cellular material, crystals, lipid, and mucus.

### Odor

Excess ammonia odor may be detectable in urine infected with urease-producing bacteria.

## Specific Gravity

### Normal

Feline: 1.025-1.060 (high normal range values may be a risk factor for feline lower urinary tract disease [FLUTD])

Canine: 1.020-1.050

### Isosthenuria (1.008-1.012)

Renal failure

Rare cases of polydipsia

### Hyposthenuria (< 1.008)

Polydipsia/polyuria (e.g., hyperthyroidism, hypercalcemia, hypokalemia, hepatic failure, psychogenic)

Diabetes insipidus

## Chemical Properties

### pH

#### Normal:

5.5-7.5 (feline and canine)

*Causes of acidic urine*: meat-based diet; administration of acidifying agents (e.g., D,L-methionine,  $\text{NH}_4\text{Cl}$ ); metabolic acidosis; respiratory acidosis; protein catabolic states; severe vomiting with chloride depletion

*Causes of alkaline urine*: vegetable-based diet; administration of alkalinizing agents (e.g.,  $\text{NaHCO}_3$ , citrate); urinary tract infection by urease-producing bacteria; postprandial alkaline tide; metabolic alkalosis; respiratory alkalosis; renal tubular acidosis (distal tubule)

### Protein

#### Normal:

0-30 mg/dL

Must be interpreted in light of urine specific gravity

Commonly used dipsticks are more sensitive to albumin than globulin.

Increased with glomerular or inflammatory disease

### Glucose

Appears in urine if the renal threshold is exceeded

Diabetes mellitus, stress (especially in cats, infuse of dextrose-containing fluids, pheochromocytoma, proximal renal tubular diseases (aminoglycoside toxicity, ARF, Fanconi syndrome, primary renal glucosuria)

### Ketones

Test pad measures acetoacetate and acetone but not beta-hydroxybutyrate, which is responsible for acidosis

Elevated in diabetes ketoacidosis, starvation, prolonged fasting, glycogen storage disease, low-carbohydrate diet, persistent fever, persistent hypoglycemia

### Occult Blood

Does not differentiate among erythrocytes (RBCs), hemoglobin, and myoglobin

Always interpreted in light of urine sediment (evaluation for RBCs)

Erythrocytes—hematuria

Hemoglobin—hemolysis

Myoglobin—rhabdomyolysis

### Bilirubin

Detectable in urine before it is elevated in serum

May be found in trace amounts in concentrated samples, especially in intact males

Bilirubinuria seen in hemolysis, liver disease, extrahepatic obstruction, fever, starvation

### Urobilinogen

Presence indicates normal enterohepatic bilirubin circulation.

## Urinary Sediment Examination

### RBCs

Normally, zero to occasional RBCs; excessive RBCs termed *hematuria* (see p. 40)

### WBCs

Normally, zero to occasional WBCs

Excessive WBCs termed *pyuria*; indicates urinary tract infection but does not localize the site of infection

### Epithelial Cells

Squamous and transitional cells, little diagnostic significance

Increased transitional cells may be seen with infection, neoplasia, and irritation of the urinary tract.

### Casts

Cylindrical molds of renal tubules composed of aggregated proteins or cells that localize disease to the kidney

Occasional hyaline or granular cast may be normal; cellular casts are always abnormal.

### Hyaline casts:

protein precipitates (Tamm–Horsfall mucoprotein and albumin); seen with proteinuric renal disease (glomerulonephritis, amyloidosis), small numbers with fever and exercise

### Granular casts:

degeneration of cells in casts or precipitation of filtered plasma proteins; suggest ischemic or

nephrotoxic renal tubular injury

### **Cellular casts:**

WBC casts (pyelonephritis), RBC casts (fragile, rare in dogs and cats), renal epithelial cell casts (acute tubular necrosis or pyelonephritis)

### **Fatty casts:**

lipid granules (nephrotic syndrome or diabetes mellitus)

### **Waxy casts:**

final stage of degeneration of granular casts (suggest intrarenal stasis)

### **Organisms:**

Small numbers of bacteria may contaminate voided or catheterized samples but usually not enough to be seen in urine sediment unless sample is allowed to incubate. Presence of large numbers of bacteria in sediment suggests urinary tract infection. Yeast and fungal hyphae usually are contaminants.

### **Crystals**

Usually of little diagnostic value; typically found in normal urine

Acidic urine may contain urate, calcium oxalate, and cystine crystals.

Alkaline urine may contain struvite, calcium phosphate, calcium carbonate, amorphous phosphate, and ammonium biurate crystals.

Bilirubin crystals may be seen with concentrated samples or with bilirubinuria.

Urate crystals may be seen in Dalmatians and with liver disease or portosystemic shunts.

Struvite crystals are seen in cats with idiopathic lower urinary tract disease, dogs, and cats with struvite urolithiasis.

Calcium oxalate in oliguric ARF suggests ethylene glycol intoxication.

Cystine crystals, when abnormal, suggest cystinuria.

### **Other Findings in Sediment**

Sperm in intact male dogs

Parasite ova; *Dioctophyma renale*, *Capillaria plica*

Microfilariae

Lipid droplets (diabetes mellitus, nephrotic syndrome, in cats with degeneration of lipid-laden tubular cells)

### **Common Bacteria Seen in Urinary Tract Infections**

*E. coli*

*Proteus* spp.

*Staphylococcus* spp.

*Pasteurella multocida*

*Enterobacter* spp.

*Klebsiella* spp.

*Pseudomonas aeruginosa*

## **Urine Cortisol/Creatinine Ratio**

Very sensitive, but not very specific test for hyperadrenocorticism  
Good test to rule out hyperadrenocorticism but not to diagnose

## Urine Protein/Creatinine Ratio

More accurate than dipstick protein estimation to assess for proteinuria  
Normal values: dogs less than 0.3, cats less than 0.6

## von Willebrand Factor

Variable degrees of expression of factor for vWD, a common, inherited hemostatic disorder (rare in cats)

Dogs with levels less than 30% are prone to spontaneous bleeding (e.g., epistaxis).

Classification of vWD in dogs:

**Type I:** low concentration of normal von Willebrand factor

**Type II:** low-normal concentration of abnormal von Willebrand factor

**Type III:** absence of von Willebrand factor

Hemostatic screening tests usually are normal in dogs with vWD.

Buccal mucosal bleeding time is the exception—best screening test.

## WBC Count



## Normal range:

Feline: 3.5-16.0  $10^3/\mu\text{L}$

Canine: 4.0-15.5  $10^3/\mu\text{L}$

## Elevated in:

infection (bacterial, systemic mycoses); physiologic leukocytosis; metabolic (stress, glucocorticoids); inflammation (immune-mediated disease, neoplasia, tissue trauma, tissue necrosis); leukemia, associated with responsive anemia (hemorrhagic anemia, hemolytic anemia)

## Decreased in:

decreased production, increased consumption, neutropenia secondary to phenobarbital administration

---

# Index

---

Note: Page numbers followed by “*t*” indicate tables, and “*b*” indicate boxes.

## A

### Abdomen

- free fluid in [2](#)

- free gas in [2](#)

### Abdominal distension [2–3](#)

- fat and [3](#)

- feces and [3](#)

- fluid and [2](#)

- gas and [2](#)

- organomegaly and [2](#)

- weakened abdominal musculature and [3](#)

### Abdominal effusions and ascites [3–4](#)

- blood and [4](#)

- chyle and [4](#)

- exudate [3](#)

- increased hydrostatic pressure and [3](#)

- modified transudate [3](#)

- transudate [3](#)

- vasculitis and [3](#)

### Abdominal fluid score (AFS) [299](#)

- in bleeding dogs [299–300](#)

### Abdominal pain, acute [4–5](#), [160–162](#)

### Abducens nerve (CN VI), deficit of [242](#)

### Abnormal cycles, in infertility [285–286](#)

### Abscess [20](#)

- prostatic [290](#)

### Acanthosis nigricans [125](#)

- canine [43](#)

### Accessory nerve (CN XI), deficit of [242](#)

### Acetylcholine receptor autoantibodies [176](#), [308](#), [308b](#)

### Acid-base status, assess [313–314](#)

### Acquired clotting factor deficiency [168](#)

### Acquired esophageal disease, differential diagnosis for [151–152](#)

Acquired hypopigmentation [45](#)  
Acquired late-onset conductive deafness [22](#)  
Acquired late-onset sensorineural deafness [22](#)  
Acquired myasthenia gravis [245](#)  
Acquired penile disorders [287](#)  
Acquired platelet dysfunction [170–171](#)  
Acquired thrombopathia [64](#)  
Acromegaly [127–128](#)  
Acromelanism [43](#)  
ACT *See* [Activated coagulation time](#)  
ACTH *See* [Adrenocorticotrophic hormone](#)  
Activated coagulation time (ACT) [308](#)  
Activated partial thromboplastin time (APTT) [308](#), [328](#)  
Acute diarrhea [23](#), [157](#)  
Acute gastritis [159](#)  
Acute pain assessment [295](#)  
Acute pain preemptive scoring system [296](#)  
Acute renal failure [9–10](#), [281](#)  
Acute vestibular “attacks,” [248](#)  
Adenovirus  
    type 1 (infectious canine hepatitis) [197](#)  
    type 2 [198](#)  
Adnexal neoplasia [263](#)  
Adrenal tumors [128–129](#)  
    functional adrenocortical [128–129](#)  
    functional adrenomedullary [129](#)  
    nonfunctional [128](#)  
Adrenocorticotrophic hormone (ACTH)  
    endogenous [308](#)  
    stimulation test [309](#), [309b](#)  
AFAST (abdominal FAST) [298](#)  
    as extension of physical exam [300–301](#)  
Aggressive behavior [5–6](#)  
Airway disorders *See* [Upper airway disorders](#)  
Alanine aminotransferase (ALT, formerly SGPT) [309](#)  
Albinism [44](#)  
Albumin [310](#)  
Aldosterone-secreting tumors [128](#)  
Algae (*Prototheca* spp.) [154](#)  
Alimentary disease [230](#) *See also* [Extraalimentary tract disease](#)  
    regurgitation and [68](#)

Alimentary tract lesion [38–39](#)  
Alimentary tract parasites, small intestinal disease and [158](#)  
Alkaline phosphatase, serum [310](#), [311b](#)  
Allergic blepharitis [259](#)  
Allergic contact dermatitis [117](#)  
Allergic respiratory tract disorders [20](#)  
Allergic skin disease [116–117](#)  
Allergic upper airway disorders [20](#)  
Allergy  
    flea [116](#)  
    gagging and [35](#)  
    otitis externa caused by [121](#)  
    pruritus and [66](#)  
    scaling and crusting caused by [71](#)  
Alopecia [6–8](#)  
    chemotherapeutic agent toxicity [227](#)  
    endocrine [117–118](#)  
    inflammatory [6–7](#)  
    noninflammatory [7–8](#)  
ALP *See* [Alkaline phosphatase, serum](#)  
ALT *See* [Alanine aminotransferase](#)  
Alveolar pattern [111](#)  
American Association of Feline Practitioners [200](#)  
American trypanosomiasis (*Trypanosoma cruzi*) [194](#)  
Ammonia [311](#), [311b](#)  
Amylase, serum [311](#), [311b](#)  
ANA *See* [Antinuclear antibody](#)  
Anal disease, hematochezia and [39](#)  
Anaphylaxis [8](#)  
Anaplasma platys [185](#)  
Anaplasmosis  
    canine [182](#), [184](#)  
        thrombocytic [185](#)  
    feline [184](#)  
Ancillary tests, diabetes mellitus and [132](#)  
Anemia [60–61](#)  
    blood loss [167](#)  
    of chronic disease [165](#)  
    hemolytic [163–164](#)  
    nonregenerative [61](#), [165–167](#)  
    regenerative [60](#), [167–168](#)

Anesthetic accidents [252](#)  
Angioedema [82](#)  
Animals, phobia and [10](#)  
Anion gap [311](#)  
Anisocoria [255–256](#)  
    neurologic causes of [256](#)  
    pharmacologic causes of [255–256](#)  
Anorectal disease [50](#)  
    fecal incontinence and [152](#)  
Anterior thoracic lesion [104](#)  
Anticoagulant rodenticides [268](#)  
Antigen test [101](#)  
Antineutrophil antibodies [176](#)  
Antinuclear antibody (ANA) [177](#), [312](#)  
Antiplatelet antibodies [176](#)  
Anuria [9–10](#)  
Anxiety [10–11](#)  
Aortic stenosis, breed predispositions to [96](#)  
APTT *See* [Activated partial thromboplastin time](#)  
Aqueous humor [257](#)  
Aqueous humor lesions, blindness and [13](#)  
Arrhythmias [78](#), [89–90](#)  
Arrhythmogenic right ventricular cardiomyopathy [108](#)  
Arterial blood gases [313](#), [313t](#)  
Arterial thromboembolism [90–91](#)  
Arteries, enlarged [112](#)  
Arteriolar dilatation, small-caliber [27](#)  
Arthritis [206–207](#)  
    differential diagnosis for  
        infectious [206–207](#)  
        noninfectious [207](#)  
Arthrocentesis *See* [Joint fluid](#)  
Ascites *See* [Abdominal effusions and ascites](#)  
Aspartate aminotransferase (AST, formerly SGOT) [314](#)  
Aspergillosis [190](#)  
Aspiration pneumonia [91–92](#)  
AST *See* [Aspartate aminotransferase](#)  
Asymmetric splenomegaly [171](#)  
Ataxia [11–12](#)  
Atopy [116](#)  
Atrial and ventricular enlargement

- left [93](#)
- right [94](#)
- Atrial enlargement, left [93](#)
- Atrial rupture, left [109](#)
- Atrial septal defect, breed predispositions to [96](#)
- Atrioventricular valve disease, chronic [92](#)
- Autoimmune diseases *See also* [Immunologic and immune-mediated disorders](#)
  - organ systems affected by [179](#)
  - otitis externa caused by [122](#)
  - of skin [175–176](#)
- Autoimmune ulcers
  - canine [29](#)
  - feline [30](#)
- Azoospermia [53](#), [287](#)
- Azotemia [10](#)

## **B**

- B lymphocytes [177](#)
- Babesiosis [193](#)
- Bacteria
  - ear canal swabs with [325](#)
  - otitis externa perpetuated by [123](#)
- Bacterial blepharitis [258–259](#)
- Bacterial colitis [154](#)
- Bacterial infections
  - of claw [118](#)
  - fever caused by [31–32](#)
  - splenomegaly caused by [173](#)
  - systemic [183–185](#)
    - differential diagnosis for [183–184](#)
    - Rickettsiales, clinical importance in dogs and cats [184–185](#)
- Bacterial L-form arthritis [206](#)
- Bacterial pericarditis [109](#)
- Bacterial pyelonephritis [279](#)
- Bacterial pyoderma [119](#)
- Bacterial scaling and crusting [70](#)
- Bacterial skin disease [190](#)
- Bacterial suppurative arthritis [206](#)
- Bartonellosis
  - canine [184–185](#)
  - feline [185](#)

Basophil count [315](#)  
Basophilia [315](#)  
Behavior *See also* [Aggressive behavior](#); [Compulsive behavior disorders](#)  
    constipation and [19](#)  
    inappropriate elimination and [48–49](#)  
    pruritus and [66](#)  
Bicarbonate ( $\text{HCO}_3^-$ ) [315](#)  
Bile acids [315](#)  
Biliary cysts [218](#)  
Biliary obstruction, posthepatic [48](#)  
Biliary tract disease [218](#)  
Bilirubin [316](#), [351](#)  
Biochemical abnormalities, arterial thromboembolism and [91](#)  
Bladder distended [51](#)  
Blastomycosis [187–188](#)  
Bleeding oral lesion, alimentary tract [39](#)  
Blindness [13–14](#)  
    acute [256–258](#)  
Blood *See also* [Complete blood count](#)  
    abdominal effusions and [4](#)  
    ingested [57](#)  
    occult [350](#)  
Blood loss  
    anemia [167](#)  
    hemolysis *versus* [164](#)  
Blood urea nitrogen (BUN) [316](#)  
Blunt trauma, AFS in [299](#)  
BMBT *See* [Buccal mucosal bleeding time](#)  
Bone disorders [207–209](#)  
    congenital [207](#)  
    developmental and genetic [208](#)  
    differential diagnosis for [207–208](#)  
    elevated serum hepatobiliary enzyme caused by [216](#)  
    endocrine [208](#)  
    idiopathic [208–209](#)  
    metabolic [208](#)  
    nutritional [208](#)  
Bone marrow suppression [63](#)  
Bone metastasis [229](#)  
Bone tumors [234](#)

Bornavirus [199](#)  
Borreliosis (Lyme disease) [183](#)  
Botulism [183–184](#)  
Boxer erosions/ulcers *See* [Spontaneous chronic corneal epithelial defects](#)  
Bradyarrhythmias, chronic [98](#)  
Bradycardia, sinus [14](#)  
Brain disease [240–241](#)  
Brain stem, ataxia and [12](#)  
Brain tissue, herniation of, coma and [77](#)  
Bromethalin rodenticides [269](#)  
Bronchi disorders [104](#)  
Bronchial pattern [111](#)  
Brown spiders *See* [Loxoscelidae](#)  
Brucellosis (dogs) [183](#)  
Buccal mucosal bleeding time (BMBT) [316](#)  
Bullous keratopathy [260](#)  
BUN *See* [Blood urea nitrogen](#)

## C

Ca *See* [Calcium](#)  
Cachexia [15](#)  
Calcinosis circumscripta, tongue diseases and [151](#)  
Calcium (Ca) [317](#)  
Calcium oxalate monohydrate or dihydrate [292](#)  
Calcium phosphate [293](#)  
Cancer  
    hematologic [229](#)  
    remote neurologic manifestations of [253](#)  
Canine (dogs)  
    acromegaly in [127](#)  
    acute pain assessment for [295](#)  
    AFS application in bleeding [299–300](#)  
    aggressive behavior in [6](#)  
    anaplasmosis in [182, 184](#)  
        thrombocytic [185](#)  
    arrhythmogenic right ventricular cardiomyopathy in [108](#)  
    autoimmune disorders in, organ systems affected by [179](#)  
    bacterial pyelonephritis in [279](#)  
    bartonellosis in [184–185](#)  
    blindness in [256–258](#)  
    brucellosis [183](#)



- chylothorax testing for [95–96](#)
- core vaccines for [196](#)
- cutaneous histiocytoma in [323](#)
- diabetes insipidus in [130–131](#)
- dilated cardiomyopathy in [107–108](#)
- ehrlichiosis in [184](#), [186–187](#)
- flea allergy in [116](#)
- food hypersensitivity in [116](#)
- glomerular disease in [274–275](#)
- glucagonoma in [135](#)
- heartworm antigen for [333](#)
- hepatobiliary disease in [217–218](#)
- histiocytic disease in [228–229](#)
- histoplasmosis in [188–189](#)
- hypertrophic cardiomyopathy in [108](#)
- hypothyroidism in [144–145](#)
- inappropriate elimination in [48–50](#)
- infertility of
  - female [285–286](#)
  - male [286–287](#)
- insulin resistance in [133–134](#)
- lymphoma in [235](#)
- myocardial diseases in [107–108](#)
- neorickettsiosis in [192](#)
- noncore vaccines for [196](#)
- nonhealing corneal erosions in [260](#)
- noninfective myocarditis in [108](#)
- pancreatitis in [221](#), [223–224](#)
- proteinuria in [278–279](#)
- renal disease in [279–280](#)
- reproductive disorders in [285–289](#)
- Rickettsiales, clinical importance in [184–185](#)
- SLE diagnostic criteria for [180–181](#)
- small intestinal disease in, breed susceptibilities to [159](#)
- thyroid neoplasms in [233–234](#)
- ulcers in [29–30](#), [119–120](#)
- uroliths in [292–293](#)
- uveitis in [266–267](#)
- vacuolar hepatopathy in [225](#)
- Canine aggression
  - pathophysiologic causes of [6](#)

- species-typical patterns of 6
- Canine cutaneous histiocytoma 228
- Canine distemper virus 197
  - clinical findings for 199–200
- Canine follicular dysplasia 7
- Canine herpesvirus 198
- Canine influenza 187
  - subtype H3N2 198
  - subtype H3N8 198
- Canine lower urinary tract disease 291–292
- Canine oral papillomavirus 198
- Canine pattern baldness 7
- Canine thrombocytic anaplasmosis 185
- Canine toxoplasmosis 193
- Canine viruses 197–200
- Carbamate insecticides 269
- Cardiac central cyanosis 21
- Cardiac output
  - reduction 92
  - syncope and 78–79
- Cardiogenic shock 61
- Cardiomegaly 93–94
- Cardiopulmonary disorders 87–306
- Cardiotoxicity 226
- Cardiovascular hemoptysis 41
- Cardiovascular respiratory tract disorders 20
- Cardiovascular system, plants affecting 270
- Caries 147
- Carnitinuria 280
- Caroli disease 213
- Casts 351
- Cataracts 262
- Catheterization, urinary retention and 75
- Cats *See* [Feline](#)
- Caudal cervical lesion 251
- CBC *See* [Complete blood count](#)
- Cecocolic intussusception 154
- Cellular casts 351
- Cellular debris 294
- Cellular immunity 178
- Central cyanosis 21

- Central nervous system
  - fecal incontinence and [153](#)
  - lymphoma [244](#)
- Central vestibular disease [243](#), [253–254](#)
  - head tilt and [37–38](#)
  - nystagmus and [59](#)
- Cerebellar lesion [254](#)
- Cerebellum, ataxia and [12](#)
- Cerebral edema, stupor and [77](#)
- Cerebral hypoperfusion, syncope and [78–79](#)
- Cerebral infarction, arterial thromboembolism and [90](#)
- Cerebral perfusion, syncope and [78](#)
- Cerebrospinal fluid (CSF) [317](#), [317t](#)
- Cerumen production, excessive [122](#)
- Cervical lesion, ventral [104](#)
- Cervical spinal cord, ataxia and [12](#)
- CH *See* [Cholesterol](#)
- Chédiak-Higashi syndrome [44](#)
- Chemical injury, erosions/ulcers and [119–120](#)
- Chemical properties [350](#)
- Chemical toxicoses [268–269](#)
- Chemotherapeutic agent toxicity [226–227](#)
- Chest tube site (CTS) view, in TFAST [303](#)
- Cheyletiellosis [123](#)
- Chiggers [124](#)
- Chloride (Cl) [318](#)
  - excessive loss of sodium relative to [318](#)
  - therapy and solutions and high sodium concentration relative to [319](#)
- Cholangitis and cholangiohepatitis, feline [210–211](#)
- Cholecalciferol (vitamin D) rodenticides and medications [269](#)
- Cholesterol (CH) [319](#)
- Cholinesterase [319](#)
- Chorioretinitis, differential diagnosis for [191–192](#)
- Chronic gastritis [159–160](#)
- Chronic pain assessment [296–297](#)
- Chronic pulmonary fibrosis [20](#)
- Chyle, abdominal effusions and [4](#)
- Chylothorax [94–96](#)
  - causes of [95](#)
    - tests for, in dogs and cats [95–96](#)
  - diagnostic criteria for [94](#)

Chylous effusion [110](#)

Cl *See* [Chloride](#)

Claw disorders [118–119](#)

Clotting factor deficiencies, inherited [168](#)

Coagulopathies

- alimentary tract lesion and [39](#)
- differential diagnosis for [168–169](#)
- sneezing and [73](#)

Cobalamin [319](#)

Coccidioidomycosis [189](#)

Cognitive dysfunction [241–242](#)

Colonic disease, hematochezia and [39–40](#)

Colonic inflammation, tenesmus and [80](#)

Colonic obstruction, constipation and [18–19](#)

Colonic weakness, constipation and [19](#)

Colorectal disease [50](#), [152](#)

Coma [77–78](#)

Complete blood count (CBC) [320](#)

- for chylothorax testing for cats and dogs [95](#)
- diabetes mellitus and [132](#)

Compulsive behavior disorders [17–18](#)

Congenital acquired sensorineural deafness [22](#)

Congenital anomalies, in ureteral diseases [289](#)

Congenital heart disease, breed predispositions to [96–97](#)

Congenital malformations [240–241](#)

Congenital myasthenia gravis [245](#)

Congenital penile disorders [287–288](#)

Congenital sensorineural deafness [22](#)

Congestion, splenomegaly and [171](#)

Conjunctivitis [261](#)

Constipation [18–19](#), [146–147](#), [155](#)

Contact mucosal ulceration from calculus contact [151](#)

Continuous murmurs [107](#)

Coombs test [321](#)

Cor triatriatum, breed predispositions to [97](#)

Coral snakes *See* [Elapids](#)

Cornea [256–257](#), [261](#)

Corneal color changes [258](#)

Corneal lesions, blindness and [13](#)

Cornified epithelial cells [293](#)

Coronavirus [197](#)

Corrected hyperchloremia [318](#)  
Corrected hypochloremia [318–319](#)  
Corticosteroid therapy [227–228](#)  
Cortisol [321](#)  
Cortisol-secreting tumors [128](#)  
Coughing [19–21](#)  
CPK *See* [Creatine kinase](#)  
Cranial cervical lesion [251](#)  
Cranial nerve (CN)  
    deficits [242](#)  
    in neurologic examination [248](#)  
Creatine kinase (CK, formerly CPK) [321](#)  
Creatinine [321](#)  
Cretinism [129](#)  
Crotalids [271–272](#)  
Cryptococcosis [189–190](#)  
Crystals [352](#)  
CSF *See* [Cerebrospinal fluid](#)  
Cutaneous disease [230](#)  
Cutaneous histiocytoma [228](#)  
Cutaneous histiocytosis [228](#)  
Cyanosis [21–22](#)  
Cyclic hematopoiesis, canine [44](#)  
Cystine [293](#)  
Cystinuria [280](#)  
Cysto-Colic (CC) view, in AFAST [301](#)  
Cystoscopy, indications for [276](#)  
Cytauxzoonosis [193](#)  
Cytologic criteria of malignancy [322](#)

## D

D-dimer [328](#), [328b](#)  
Deafness [22](#)  
    acquired late-onset conductive [22](#)  
    acquired late-onset sensorineural [22](#)  
    congenital acquired sensorineural [22](#)  
    congenital sensorineural [22](#)  
Decreased plasma oncotic pressure [113](#)  
Deep folliculitis [121](#)  
Deep pyoderma [126](#)  
Defecation, refusal, constipation and [19](#)

Demodicosis [123](#), [125](#)  
Dental and oral cavity diseases [147–148](#)  
Depigmenting skin diseases [176](#)  
Dermatologic disorders [87–306](#)  
    halitosis and [36–37](#)  
Dermatophytes, otitis externa caused by [121](#)  
Dermatophytosis [125](#)  
Developmental/congenital neuropathies [249–250](#)  
Dexamethasone suppression tests [328](#)  
Diabetes insipidus [130–131](#)  
    causes in dogs and cats [130–131](#)  
    differential diagnosis for [130](#)  
    nephrogenic [280–281](#)  
Diabetes mellitus [131–134](#)  
    clinicopathologic abnormalities, uncomplicated [132](#)  
    complications and [132–133](#)  
    factors in etiopathogenesis and [131–132](#)  
    insulin resistance, causes of [133–134](#)  
    insulin-secreting tumors and [134](#)  
Diabetic ketoacidosis [131](#)  
Diaphragmatic-Hepatic (DH) view  
    in AFAST [300–301](#)  
    in TFAST [302–303](#)  
Diarrhea [148–150](#)  
    acute [23](#), [157](#)  
    causes of [148](#)  
    chronic [23–24](#)  
    classification of [149](#)  
    infectious [157–158](#)  
Diastolic murmurs [106–107](#)  
DIC *See* [Disseminated intravascular coagulation](#)  
2,4-dichlorophenoxyacetic acid [269](#)  
Diet  
    acute diarrhea caused by [23](#)  
    constipation and [18](#)  
    halitosis and [37](#)  
    vomiting and [83](#)  
Dietary intolerance, large intestinal disease and [154](#)  
Dilated cardiomyopathy [107–108](#)  
Diptera [124](#)  
Direct Coombs test [176](#)

Direct immunofluorescence [177](#)  
Discharge, vaginal [293–294](#)  
Discrete cells (round cells), tumors and [322](#)  
Disseminated intravascular coagulation (DIC) [328](#)  
Dogs *See* [Canine](#)  
Drug eruption [118](#)  
Drug-induced hepatopathy [217](#)  
Drugs  
    affecting male reproduction [288–289](#)  
    anaphylaxis and [8](#)  
    constipation and [19](#)  
    elevated serum hepatobiliary enzyme caused by [216](#)  
    hemolytic anemia triggered by [163–164](#)  
    hypoglycemia caused by [138](#)  
    melena and [58](#)  
    miosis caused by [255](#)  
    mydriasis caused by [256](#)  
    pancreatitis and [222](#)  
    vomiting and [83](#)  
Duodenal reflux [222](#)  
Dwarfism, pituitary [143](#)  
Dyschezia [79–80](#)  
Dysphagia [24–25](#)  
Dysplasia, canine follicular [7](#)  
Dyspnea [25–26](#)  
Dysuria [75–76](#)

## E

Ear canal swabs, cytology of [325–326](#)  
    bacteria in [325](#)  
    fungi in [326](#)  
    neoplasia in [326](#)  
Ear mites [123](#)  
Ecchymoses [63–64](#)  
Edema [27–28](#)  
Ehrlichiosis, canine [184](#), [186–187](#)  
Elapids (coral snakes) [272](#)  
Encephalopathy, hepatic [214](#)  
Endocrine disease [15](#), [253](#)  
    diarrhea caused by [148](#)  
    otitis externa caused by [121](#)

- regurgitation and [69](#)
- Endocrine system
  - autoimmune disorders affecting [179](#)
  - chronic constipation and [146](#)
- Endocrinopathies [125](#)
  - elevated serum hepatobiliary enzyme caused by [216](#)
- Endogenous neurotoxins [253](#)
- Enlarged arteries [112](#)
- Enlarged veins [112](#)
- Enteric virus [205](#)
- Environment, constipation and [19](#)
- Environmental and behavioral differential diagnosis, chronic constipation and [147](#)
- Eosinophil count [329](#)
- Eosinophilia [329](#)
- Eosinophilic disorder, splenomegaly and [172](#)
- Eosinophilic effusion [347](#)
- Eosinophilic granuloma complex [148](#)
- Eosinophilic granulomas [151](#)
- Eosinophils [178](#)
- Epilepsy, idiopathic [72](#)
- Epileptic seizures, paroxysmal disorders confused with [248](#)
- Epinephrine-secreting tumors [129](#)
- Episodic weakness [248](#)
- Epistaxis [28](#)
  - local causes of [28](#)
  - systemic causes of [28](#)
- Epithelial cells [351](#)
  - cornified [293](#)
  - normal, cytologic features of [325](#)
- Epithelial tumors [237](#), [239](#)
- Erosions *See* [Ulcers](#)
- Erosive immune-mediated arthritides [177](#)
- Erythema [264](#)
- Erythrocyte count (RBC count) [329](#)
- Erythrocytic parasites, in regenerative anemia [167](#)
- Esophageal disease [151–152](#)
  - alimentary tract lesion caused by [39](#)
  - aspiration pneumonia and [91](#)
  - regurgitation and [68](#)
- Estrus, abnormal [52](#)
- Ethanol [268](#)



- Ethylene glycol [268](#)
- Excessive salivation *See* [Ptyalism](#)
- Excoriation, erosions/ulcers and [119](#)
- Exercise hyperthermia [44](#)
- Exocrine pancreatic disease [211](#)
  - clinical findings of [211–212](#)
  - differential diagnosis for [211](#)
- Exogenous neurotoxins [253](#)
- Expiratory dyspnea [26](#)
- Extraalimentary tract disease, vomiting and [83](#)
- Extraalimentary tract lesion [39](#)
- Extrahepatic biliary disease *See* [Gallbladder and extrahepatic biliary disease](#)
- Extramedullary hematopoiesis, splenomegaly and [172](#)
- Extrathoracic tracheal disease
  - dyspnea and [26](#)
  - stridor and [75](#)
- Extraurinary disease, hematuria and [40](#)
- Extravasation [227](#)
- Exudative retinal detachment, diagnosis for [191–192](#)
- Eye, autoimmune disorders affecting [179](#)
- Eyelids [261](#)
  - miscellaneous diseases of [260](#)
  - periocular skin and [258–260](#)
  - pigmentary changes involving [259](#)

## F

- Facial nerve (CN VII)
  - deficit of [242](#)
  - paralysis [249](#)
- Factitious hypoglycemia [141](#)
- Failure to grow/thrive [30–31](#)
- Fanconi syndrome [280](#)
- FAST ultrasound [87–306](#)
- Fatty casts [351](#)
- Fears [10](#)
- Fecal house soiling [49](#)
- Fecal incontinence [50–51, 152–153](#)
- Feline (cats)
  - acromegaly in [128](#)
  - acute pain assessment for [295](#)
  - aggressive behavior in [5–6](#)

anaplasmosis in [184](#)  
arrhythmogenic right ventricular cardiomyopathy in [109](#)  
autoimmune disorders in, organ systems affected by [179](#)  
bacterial pyelonephritis in [279](#)  
bartonellosis in [185](#)  
blindness in [256–258](#)  
cholangitis and cholangiohepatitis in [210–211](#)  
chronic constipation in [146–147](#)  
chylothorax testing for [95–96](#)  
core vaccines for [196](#)  
diabetes insipidus in [130–131](#)  
dilated cardiomyopathy in [108–109](#)  
flea allergy in [116](#)  
food hypersensitivity in [116](#)  
glomerular disease [275–276](#)  
heartworm antibody for [333](#)  
heartworm antigen for [333](#)  
hepatobiliary disease in [218–219](#)  
histiocytic disease in [229](#)  
histoplasmosis in [188–189](#)  
hyperthyroidism in [143–144](#)  
hypertrophic cardiomyopathy in [108](#)  
inappropriate elimination in [49–50](#)  
influenza in [187](#)  
insulin resistance in [133–134](#)  
lymphoma in [235](#)  
mycoplasmosis in [184](#)  
myocardial diseases in [108–109](#)  
myocarditis in [109](#)  
noncore vaccines for [197](#)  
pancreatitis in [221–224](#)  
proteinuria in [278–279](#)  
rabies virus infection in [201](#)  
renal disease in [279–280](#)  
restrictive cardiomyopathy in [108](#)  
Rickettsiales, clinical importance in [184–185](#)  
SLE diagnostic criteria for [180–181](#)  
thyroid neoplasms in [233](#)  
ulcers in [30](#), [120–121](#)  
uveitis in [266–267](#)  
Feline acromelanism [125](#)

- Feline aggression
  - pathophysiologic causes of [5](#)
  - species-typical patterns of [6](#)
- Feline congenital/hereditary alopecia [7](#)
- Feline coronavirus infection *See* [Feline infectious peritonitis](#)
- Feline dental resorptive lesions [147](#)
- Feline histiocytic sarcoma [229](#)
- Feline immunodeficiency virus (FIV), clinical findings for [202–203](#)
- Feline infectious peritonitis (FIP, Feline coronavirus infection) [201–202](#)
- Feline leukemia virus (FeLV)
  - clinical findings for [203–204](#)
  - possible outcomes after exposure to [204–205](#)
- Feline lower urinary tract disease [292](#)
- Feline pinna alopecia [7](#)
- Feline plague (*Yersinia pestis*) [184](#)
- Feline progressive histiocytosis [229](#)
- Feline toxoplasmosis [193](#)
- Feline viruses [200](#)
  - FeLV
    - clinical findings for [203–204](#)
    - possible outcomes after exposure to [204–205](#)
  - FIP, clinical findings for [201–202](#)
  - FIV infection, clinical findings for [202–203](#)
  - guidelines for retroviral testing of [200](#)
  - other feline viral diseases [205](#)
  - rabies virus infection, clinical signs of [201](#)
- FeLV *See* [Feline leukemia virus](#)
- Female
  - genital dermatoses of [36](#)
  - infertility in [52–53](#)
- Fever *See also* [Rickettsioses](#); [Rocky Mountain spotted fever](#)
  - hyperthermia and [43](#)
- Fever of unknown origin [31–33](#)
  - caused by infection [31–32](#)
  - immune-mediated [33](#)
  - inflammatory [33](#)
  - neoplasia and [32–33](#)
- Fibrin degradation products [328](#)
- Fibrin deposition [262](#)
- Fibrinogen [328](#)
- Fine-needle biopsy [340](#)

FIP *See* [Feline infectious peritonitis](#)  
FIV *See* [Feline immunodeficiency virus](#)  
Flatulence [33–34](#)  
Flea allergy [116](#)  
Fleas [123](#)  
Fluid retention, signs related to [99](#)  
Focal erythema [264](#)  
Focal hepatomegaly [219–220](#)  
Focal mediastinal enlargement [105–106](#)  
Focal pustular/crusting dermatosis [175](#)  
Folate [331](#)  
Folliculitis [121](#)  
Food *See also* [Diet](#)  
    anaphylaxis and [8](#)  
Food allergy, large intestinal disease and [154](#)  
Food hypersensitivity [116](#)  
Forebrain disease [11–12](#)  
Foreign bodies  
    alimentary tract lesion caused by [38](#)  
    otitis externa caused by [121](#)  
    sneezing caused by [73](#)  
Forrester classification [98](#)  
Fragmentation, microangiopathic, in regenerative anemia [167–168](#)  
Free T<sub>4</sub> (FT<sub>4</sub>) [347](#)  
Fructosamine [331](#), [331b](#)  
Functional adrenal tumor (FAT) [328](#)  
Fundus [261–263](#)  
Fungal arthritis [206](#)  
Fungal blepharitis [259](#)  
Fungal canine ulcers [29](#)  
Fungal colitis [154](#)  
Fungal infection  
    of claw [118](#)  
    fever caused by [32](#)  
    splenomegaly caused by [173](#)  
Fungal pericarditis [109](#)  
Fungal scaling and crusting [70](#)  
Fungi, ear canal swabs with [326](#)  
Furunculosis [121](#)

## G

- Gagging [34–35](#)
- Gait, in neurologic examination [247](#)
- Gallbladder and extrahepatic biliary disease [212–214](#)
  - alimentary tract lesion caused by [39](#)
  - clinical findings of [213–214](#)
  - differential diagnosis for [212–213](#)
- Gallbladder rupture [213](#)
- Gamma glutamyltransferase (GGT) [331](#), [332b](#)
- Gasoline [268](#)
- Gastric dilatation/volvulus [160](#)
- Gastric disease, vomiting caused by [82](#)
- Gastric outflow obstruction [160](#)
- Gastric stasis [160](#)
- Gastric ulceration/erosion [160](#)
- Gastrinoma (Zollinger-Ellison syndrome) [134–135](#)
- Gastritis [38](#), [159–160](#)
- Gastroenterologic disorders [87–306](#)
- Gastrointestinal disease [139](#)
  - acute abdomen caused by [160–161](#)
  - diarrhea caused by [148](#)
  - elevated serum hepatobiliary enzyme caused by [217](#)
  - halitosis and [36](#)
- Gastrointestinal hemorrhage, protein-losing enteropathy and [156](#)
- Gastrointestinal inflammation, upper [58](#)
- Gastrointestinal loss [318–319](#)
- Gastrointestinal system
  - acute abdominal pain and [4](#)
  - autoimmune disorders affecting [179](#)
  - plants affecting [270–271](#)
  - ulceration/erosion of [38](#)
- Gastrointestinal toxicity [226](#)
- Generalized acute neuropathies [249](#)
- Generalized anxiety [11](#)
- Generalized chronic polyneuropathies [249](#)
- Generalized hepatomegaly [219](#)
- Generalized pustular/crusting dermatosis [175](#)
- Genetic predisposition, hemolytic anemia triggered by [164](#)
- Genital dermatoses [35–36](#)
  - in female [36](#)
  - prepuce/sheath lesions [35](#)
  - scrotum lesions [35](#)

Germ cell tumors [239](#)  
GFAST (global FAST) [298](#)  
    triad for volume status and patient monitoring [306](#)  
GGT *See* [Gamma glutamyltransferase](#)  
Gila monster *See* [Helodermatidae lizard](#)  
Glandular conditions, otitis externa caused by [122](#)  
Gliomas *See* [Neuroepithelial tumors](#)  
Globulin [332](#)  
Glomerular disease [273–276](#)  
    differential diagnosis for  
        in cats [275–276](#)  
        in dogs [274–275](#)  
    types of [273–274](#)  
Glomerulopathy [3](#)  
Glossopharyngeal nerve (CN IX), deficit of [242](#)  
Glucagonoma [135](#)  
Glucocorticoid administration, adverse effects of [227–228](#)  
Glucose [332](#), [350](#)  
    decreased production of [138](#)  
    excess consumption of [138](#)  
Glucose tolerance test [333](#)  
Glycosylated hemoglobin [333](#)  
Granular casts [351](#)  
Granuloma [20](#)  
Granulomatous disease, splenomegaly and [172](#)  
Granulomatous infiltrates [262](#)  
Graying [44](#)  
Grooming behavior, halitosis and [37](#)

## H

Halitosis [36–37](#)  
    dermatologic disorders causing [36–37](#)  
    diet causing [37](#)  
    gastrointestinal disease causing [36](#)  
    grooming behavior causing [37](#)  
    metabolic disease causing [36](#)  
    oral disease causing [36](#)  
    respiratory disease causing [36](#)  
Hallucinatory compulsive disorder  
    canine [17](#)  
    feline [18](#)

HCO<sub>3</sub>. *See* [Bicarbonate](#)

Head tilt [37–38](#), [243](#)

- central vestibular disease [37–38](#)
- peripheral vestibular disease [37](#)

Heart failure [97–99](#)

- causes of chronic [97–98](#)
- clinical findings for [98–99](#)
- left-sided [97](#), [99](#)
- right-sided [97–99](#)
- severity classification for [98](#)
- signs of [91](#)

Heartworm, dyspnea and [26](#)

Heartworm antibody

- feline [333](#)
- tests [95](#)

Heartworm antigen

- canine [333](#)
- tests [95](#)

Heartworm disease [99–101](#)

Heat stroke, hyperthermia and [44](#)

Heavy metal intoxication [38](#)

Heinz body, regenerative anemia and [167](#)

Helminth parasites [124](#)

Helodermatidae lizard (Gila monster) [272](#)

Hemangiosarcoma [232–233](#)

Hematemesis [38–39](#)

Hematochezia [39–40](#)

Hematocrit (packed cell volume, PCV) [334](#)

Hematologic abnormalities, arterial thromboembolism and [91](#)

Hematologic cancers [229](#)

Hematologic disorders [87–306](#)

- autoimmune disorders and [179](#)

Hematopoietic tumors [235](#)

Hematuria [40](#)

Hemoglobin [334](#)

Hemolympathic neoplasia [219](#)

Hemolysis [47](#)

- blood loss and [164](#)
- plants causing [270](#)
- prevention in laboratory samples [334–335](#)

- regenerative anemia and 167
- Hemolytic anemia 163–164
- Hemoptysis 41
- Hemorrhage 261
  - focal erythema and 264
  - pleural effusion differential and 110
  - prolonged 41 *See also* Coagulopathies; Platelet dysfunction; Thrombocytopenia
- Hemorrhagic gastroenteritis 159
- Hemostatic defects 169
- Hemostatic test results, expected 169
- Hepatic encephalopathy 214
- Hepatic failure 139
- Hepatic lipidosis 218
  - feline 214–215
- Hepato-Renal (HR) umbilical view, in AFAST 301–302
- Hepatobiliary disease 47, 215–219
  - acute abdomen caused by 161
  - clinical and physical findings for 215–216
  - differential diagnosis for
    - in cats 218–219
    - in dogs 217–218
  - elevated serum hepatobiliary enzymes caused by 216–217
- Hepatobiliary system, acute abdominal pain and 5
- Hepatoencephalopathy 253
- Hepatomegaly 219–220
- Hepatopathy 226
- Hepatozoonosis 193
- Hereditary hyperpigmentation 42–43
- Hereditary hypopigmentation 44–45
- Hereditary platelet dysfunction 171
- Herniation of brain tissue, coma and 77
- Herpesvirus, canine 198
- High-dose dexamethasone suppression test 328
- Histiocytic disease 228–229
- Histiocytic sarcoma 229, 323
- Histoplasmosis 188–189
- Horizontal nystagmus 58–59
- Horner syndrome 41–42
- Household corrosives 268
- Humoral hypercalcemia 229–230
- Humoral immunity 177



Hyaline casts [351](#)

Hydrostatic pressure

- abdominal effusions and ascites and [3](#)
- edema and [27](#)

Hymenopteran stings [272](#)

Hyperadrenocorticism [135–136](#)

Hyperchylomicronemia [249](#)

Hyperglycemia [136–137](#), [332](#)

Hyperkalemia [139–140](#)

Hyperlipidemia [220–221](#)

Hyperlipoproteinemia [222](#)

Hyperparathyroidism [141](#)

Hyperpigmentation [42–43](#), [125](#)

Hyperplasia, splenomegaly and [171](#)

Hypersensitivity [227](#)

Hypersensitivity reaction, immediate, in urticaria/angioedema [82](#)

Hypertension [101–103](#), [252](#)

- portal [3](#)
- pulmonary [101–102](#)
- sneezing and [73](#)
- systemic [102–103](#)

Hyperthermia [43–44](#)

Hyperthyroidism, feline [143–144](#)

Hypertriglyceridemia [222](#)

Hypertrophic cardiomyopathy [108](#)

Hypertrophic osteopathy [232](#)

Hyperuricosuria [280](#)

Hyperviscosity, sneezing and [74](#)

Hyperxanthinuria [280](#)

Hyphema [261](#)

Hypoadrenocorticism [137–138](#)

Hypoalbuminemia [3](#) *See also* [Albumin](#)

Hypoglossal nerve (CN XII), deficit of [242](#)

Hypoglycemia [138](#), [141](#), [252](#), [332–333](#)

Hyponatremia [139–140](#)

Hypoparathyroidism [141–142](#)

Hypopigmentation [44–45](#), [124](#)

Hypoproteinemia [27](#)

Hypotension [216–217](#)

Hypothermia [46–47](#)

Hypothyroidism

- canine 144–145
- otitis externa caused by 121
- in puppies 129

Hypoventilation 21

Hypoxemia, potential causes of 313

Hypoxia 216–217, 252

## I

Iatrogenic blepharitis 259

Icterus (jaundice) 47–48

Idiopathic epilepsy 72

Idiopathic peripheral vestibular disease 249

Ileus 153–154

Immune mediated/autoimmune canine ulcers 29

Immune mediated/autoimmune feline ulcers 30

Immune system, components of 177–178

Immune-mediated arthritis 177

Immune-mediated blepharitis 259

Immune-mediated disorders 176–177

- erosions/ulcers and 120
- gagging and 35
- hemolytic anemia triggered by 163
- regurgitation and 68
- of tongue 150–151

Immune-mediated joint disease 336–337

Immunoassays 335

Immunologic and immune-mediated disorders 87–306

Immunopathologic injury, mechanisms of 178–179

Impaired venous return 27

Impression smear 340

Inappropriate elimination 48–50, 273

Incontinence

- fecal 50–51
- urinary 51

Incoordination 11–12

Increased vascular permeability 113

Indolent erosions/ulcers *See Spontaneous chronic corneal epithelial defects*

Ineffective erythropoiesis 166

Infections

- acute diarrhea caused by 23
- claw 118

- erosions/ulcers and 119–120
- fever caused by 31–32
- gagging and 34
- glomerular disease and 274–275
- hemolytic anemia triggered by 163
- lameness caused by 55
- lymphadenopathy and 56–57
- melena and 58
- protein-losing enteropathy and 156
- pruritus and 66
- regurgitation and 69
- sneezing and 72
- Infectious blepharitis 258–260
- Infectious canine hepatitis *See* Adenovirus, type 1
- Infectious canine ulcers 29
- Infectious diarrhea 157–158
- Infectious disease 87–306
- Infectious feline ulcers 30
- Infertility
  - female 52–53, 285–286
    - abnormal cycles 52, 285–286
    - normal cycles 52, 285
    - not cycling 53, 286
  - male 53–54, 286–287
- Infiltrative disease 160
  - alimentary tract lesion caused by 38
- Infiltrative lymphadenopathies 56
- Inflammation
  - bladder or urethra 292
  - chronic constipation and 146
  - colonic 80
  - edema and 27
  - glomerular disease and 274–276
  - hemolytic anemia triggered by 164
  - hepatobiliary disease and 217
  - lameness caused by 56
  - of large intestine 154
  - perineal 80
  - protein-losing enteropathy and 156
  - rectal 80
  - splenomegaly and 172

- Inflammatory alopecia [6–7](#)
- Inflammatory disease
  - erosions/ulcers and [121](#)
  - of nervous system [243–244](#)
- Inflammatory ejaculate [53](#), [286](#)
- Inflammatory hepatobiliary disease [218](#)
- Inflammatory lymphadenopathies [56–57](#)
- Inflammatory myopathies [15](#), [245–246](#)
- Inflammatory respiratory tract disorders [20](#)
- Inflammatory upper airway disorders [19](#)
- Influenza
  - canine [187](#)
    - subtype H3N2 [198](#)
    - subtype H3N8 [198](#)
  - feline [187](#)
- Ingested blood [57](#)
- Inherited clotting factor deficiencies [168](#)
- Inherited myopathies [15](#), [246](#)
- Inherited thrombopathia [63](#)
- Inspiratory dyspnea [25–26](#)
- Insulin [133–134](#), [138](#), [335](#)
- Insulin-secreting B-cell neoplasia [140–141](#)
- Insulin-secreting tumors [134](#)
- Insulinoma [140–141](#)
- Interestrual interval, abnormal [52](#)
- Intestinal obstruction [158](#)
- Intoxicants, vomiting caused by [83](#)
- Intracranial neoplasms [244](#)
- Intracranial pressure, increased, coma and [77](#)
- Intranasal disorders, stertor and [74](#)
- Intraocular neoplasia [264](#)
- Intrathoracic trachea, dyspnea and [26](#)
- Intussusception [158](#)
- Iris abnormalities [262](#)
- Iron [269](#)
- Iron-binding capacity, total [336](#)
- Irritable bowel syndrome [158](#)
- Ischemia [222](#)
- Ischemic neuromyopathy [249](#)

## J

Jaundice [47–48](#)  
Joint disorders [87–306](#)  
Joint fluid (arthrocentesis) [336](#)  
Joint swelling [54–55](#)  
Joint tumors [234](#)

## K

Keratinization defects [71](#)  
Keratoconjunctivitis sicca [261](#)  
Kerosene [268](#)  
Ketones [350](#)  
Kidney *See also* [Renal disease](#)  
    autoimmune disorders affecting [179](#)  
    urogenital tumors and [237–238](#)

## L

Laboratory values, interpretation of results of [308b](#)  
Lagenidiosis [190](#)  
*Lagenidium giganteum* *See* [Lagenidiosis](#)  
Lameness [55–56](#)  
Langerhans cell histiocytoma [228](#)  
Large bladder, stranguria in [75](#)  
Large bowel diarrhea [24](#)  
Large intestinal disease [83](#), [154–155](#)  
Laryngeal disease [103–104](#)  
    dyspnea and [26](#)  
    stridor and [74–75](#)  
Laryngeal paralysis, causes of [103–104](#)  
*Latrodectus* spp. (widow spiders) [272](#)  
LDDST *See* [Low-dose dexamethasone suppression test](#)  
Lead [269](#)  
Left atrial and ventricular enlargement [93](#)  
Left atrial enlargement [93](#)  
Left atrial rupture [109](#)  
Leishmaniasis [194](#)  
Lens [257](#), [261–263](#)  
Lens lesions, blindness and [13](#)  
Lens luxation/subluxation [262](#)  
Lentigines [42](#)  
Lentigo [125](#)  
Lentigo simplex [125](#)

Leptospirosis [183](#)  
Leukocyte disorders [170](#)  
Leukopenia, nonregenerative anemia and [166–167](#)  
Libido [53](#)  
    abnormal [287](#)  
    normal [287](#)  
Lice [124](#)  
Ligaments, trauma to, lameness caused by [56](#)  
Limb paresis, acute, arterial thromboembolism and [90](#)  
Lipase [338](#), [338b](#)  
Lipoprotein lipase deficiency [219](#)  
Litterbox aversion [49](#)  
Liver disease [87–306](#)  
    diarrhea caused by [148](#)  
Location aversion [50](#)  
Locomotor compulsive disorder  
    canine [17](#)  
    feline [18](#)  
Low-dose dexamethasone suppression test (LDDST) [328](#)  
Lower respiratory tract disease [104–105](#)  
Lower urinary tract disease, hematuria and [40](#)  
Lower urinary tract infection [290](#)  
Loxoscelidae (recluse or brown spiders) [272](#)  
Lumbosacral spinal cord  
    ataxia and [12](#)  
    lesion of [251](#)  
Lungworms, dyspnea and [26](#)  
Lyme arthritis [206](#)  
Lyme disease [183](#)  
Lymph node enlargement [56–57](#)  
Lymphadenopathy [56–57](#), [230](#)  
Lymphangiectasia, protein-losing enteropathy and [156](#)  
Lymphangiography, chylothorax testing and [96](#)  
Lymphangiosarcoma, hyponatremia/hyperkalemia and [139](#)  
Lymphatic obstruction [27](#), [114](#)  
Lymphocyte count [338](#)  
Lymphocytic cholangitis [210–211](#)  
Lymphocytic thyroiditis, test for [347–348](#)  
Lymphocytosis [338–339](#)  
Lymphoid leukemia [235](#)  
Lymphoma [230](#), [235](#), [323](#)

Lymphopenia [339](#)  
Lymphoplasmacytic disease, splenomegaly and [172–173](#)

## M

Macrocytosis [339](#)  
Magnesium (Mg) [339](#)  
Magnesium-ammonium-phosphate [292](#)  
Malabsorptive diseases [155](#), [158](#)  
Maldigestive disease [158](#)  
Malignant histiocytosis [229](#), [323](#)  
Mammary gland, urogenital tumors and [239](#)  
Mammary masses [277](#)  
Marrow disorders [165–166](#)  
Masses  
    focal erythema and [264](#)  
    mammary [277](#)  
    splenic [171](#)  
Mast cell tumor (MCT) [235–236](#), [323](#)  
Mating ability, abnormal [287](#)  
    normal libido and [54](#)  
MCT *See* [Mast cell tumor](#)  
MCV *See* [Mean corpuscular volume](#)  
Mean corpuscular volume (MCV) [339](#)  
Mechanical obstruction  
    chronic constipation and [146](#)  
    gagging and [34](#)  
Mediastinal disease [105–106](#), [230](#)  
Melanocytic tumors [237](#)  
Melanoma [324](#)  
Melena [57–58](#)  
Meningioma [244](#)  
Mental state, in neurologic examination [246](#)  
Mentation, decreased, aspiration pneumonia and [91–92](#)  
Mesenchymal cells, cytologic features of [324–325](#)  
Mesenteric infarction, arterial thromboembolism and [90](#)  
Metabolic canine ulcers [29](#)  
Metabolic derangements, erosions/ulcers and [119–120](#)  
Metabolic disorders [87–306](#)  
    affecting male reproduction [288–289](#)  
    gagging and [34](#)  
    halitosis and [36](#)

- tongue diseases and [150](#)
- Metabolic feline ulcers [30](#)
- Metabolic liver disease [218](#)
- Metabolic myopathies [246](#)
- Metabolic/nutritional blepharitis [259](#)
- Metabolic system, chronic constipation and [146](#)
- Metastatic neoplasia [219](#)
  - to central nervous system [244](#)
- Methanol [268](#)
- Methemoglobinemia [21](#), [339](#)
- Mg *See* [Magnesium](#)
- Microcytosis [339](#)
- Microhepatica [220](#)
- Microvascular permeability, increased, edema and [28](#)
- Mineral seal oil [268](#)
- Miosis, conditions causing [255](#)
- Mites, ear [123](#), [326](#)
- Mitral dysplasia, breed predispositions to [96](#)
- Modified Knott or filter test [101](#)
- Modified transudates [3](#), [110](#)
- Moisture, excessive, otitis externa predisposition and [122](#)
- Monocyte count [340](#)
- Monocytosis [340](#)
- Mononuclear phagocytic cells [178](#)
- Morphology, abnormal [287](#)
- Mothballs *See* [Naphthalene](#)
- Motility, abnormal [53](#), [287](#)
- Movement disorders [241](#), [248](#)
- Mucocutaneous hypopigmentation [45](#)
- Mucocutaneous ulcerations [175](#)
- Mucosal ulcerations [175](#)
- Mucus [293](#)
- Murmurs [106–107](#)
  - clinical findings for [106–107](#)
  - grading for [107](#)
- Muscle injury [216](#)
- Muscle lameness [56](#)
- Muscle tone, in neurologic examination [247](#)
- Muscle wasting [15–16](#)
- Musculoskeletal system, acute abdominal pain and [5](#)
- Myasthenia gravis [104](#), [245](#), [248](#)



Mycobacteriosis [183](#)  
*Mycoplasma* arthritis [206](#)  
Mycoplasmosis, cats [184](#)  
Mycoses, systemic [187–192](#)  
    clinical findings for [187–190](#)  
    systemic manifestations of [190–191](#)  
Mydriasis, conditions causing [255](#)  
Myeloproliferative disorders [235](#)  
Myelosuppression [226](#)  
Myocardial diseases [107–109](#)  
Myocardial failure [97](#)  
Myocarditis, in cats [109](#)  
Myoglobinuria [340](#)  
Myopathies, myositis and [245–246](#)  
Myositis, myopathies and [245–246](#)

## N

Naphthalene (mothballs) [268](#)  
Nasal discharge [72–74](#)  
Nasal hypopigmentation [45](#)  
Nasal obstruction, dyspnea and [25–26](#)  
Nasal swabs, cytology of [326–327](#)  
Necrotic tissue, splenomegaly and [173](#)  
Neoplasia [3](#), [20](#), [87–306](#)  
    adnexal [263](#)  
    dental and oral cavity diseases and [147–148](#)  
    ear canal swabs and [326](#)  
    elevated serum hepatobiliary enzymes caused by [216](#)  
    erosions/ulcers and [119–120](#)  
    gagging and [34](#)  
    gallbladder and extrahepatic biliary disease and [213](#)  
    glomerular disease and [275–276](#)  
    hemolympathic [219](#)  
    hemolytic anemia triggered by [164](#)  
    hyperpigmentation and [125](#)  
    infiltrative lymphadenopathies and [56](#)  
    insulin-secreting B-cell [140–141](#)  
    intraocular [264](#)  
    lameness caused by [55](#)  
    melena and [34](#)  
    metastatic [219](#)

- to central nervous system [244](#)
- nodular skin disease and [191](#)
- ocular [263–264](#)
- orbital [263](#)
- pericardial effusion and [109](#)
- primary hepatic [219](#)
- protein-losing enteropathy and [156](#)
- small intestinal disease and [159](#)
- sneezing and [73](#)
- splenomegaly and [172](#)
- surface ocular [263](#)
- testicular [238](#)
- tongue diseases and [150](#)
- Neoplasms
  - benign [236](#)
  - intracranial [244](#)
  - of large intestine [154–155](#)
  - malignant [236](#)
  - plasma cell [235](#)
  - thyroid [233–234](#)
- Neoplastic blepharitis [259](#)
- Neoplastic canine ulcers [29](#)
- Neoplastic feline ulcers [30](#)
- Neoplastic upper airway disorders [20](#)
- Neorickettsiosis [184](#), [192](#)
- Neosporosis [193](#)
- Nephrogenic diabetes insipidus [280–281](#)
- Nephrotoxicity [226](#)
- Neuroepithelial tumors [244](#)
- Neurologic disease [87–306](#)
  - fecal incontinence and [50–51](#)
  - muscle wasting and [16](#)
  - vomiting caused by [83](#)
- Neurologic examination [246–248](#)
  - for urinary retention [75](#)
- Neurologic system
  - autoimmune disorders affecting [179](#)
  - plants affecting [271](#)
- Neurologic toxicity [227](#)
- Neuromuscular disease [87–306](#)
  - dysphagia and [25](#)

- localized 19
- Neuromuscular dysfunction, chronic constipation and 146
- Neuromuscular junction abnormalities 68
- Neuropathies, regurgitation and 68
- Neutropenia 341
- Neutrophil count 341
- Neutrophilia 341
- Neutrophils 178, 294
- Nevus 125
- New York Heart Association Functional Classification 98
- Nodular interstitial patterns 112
- Nodular skin disease, differential diagnosis for 190–191
- Noise, phobia and 10
- Noncardiogenic shock 61
- Noncardiopulmonary disease, dyspnea and 26
- Nonerosive immune-mediated arthritides 177
- Nonhealing corneal erosions, in dogs 260
- Nonimmunologic stimulus, in urticaria/angioedema 82
- Noninfectious pyogranulomatous skin disease 191
- Noninfective myocarditis, in dogs 108
- Nonmucosal ulcerations 175–176
- Nonneoplastic infiltrative disease, splenomegaly and 172
- Nonneurologic disease 50
- Nonregenerative anemia 61, 165–167
- Nonseptic exudates 3, 110
- Normal cycles, in infertility 285
- Normotension 78–79
- Nutrition
  - gagging and 34
  - pancreatitis and 222
- Nutritional deficiency, lameness caused by 55
- Nystagmus 58–59

## O

- Obesity 59–60
- Obsessive compulsive disorder 248
- Obstruction, urethral 291
- Obstructive ear disease 122
- Obstructive lesions, dysphagia and 25
- Ocular disorders 87–306
- Ocular neoplasia 263–264

Oculomotor nerve (CN III), deficit of [242](#)  
Olfactory nerve (CN I), deficit of [242](#)  
Oliguria [9–10](#)  
Optic nerve (CN II)  
    deficit of [242](#)  
    disease [257](#)  
Oral cavity diseases [66–67](#), [147–148](#)  
Oral cavity tumors [236](#)  
Oral compulsive disorder  
    canine [17](#)  
    feline [18](#)  
Oral disease, halitosis and [36](#)  
Oral lesions, dysphagia and [24–25](#)  
Orbital neoplasia [263](#)  
Organisms [351–352](#)  
Organomegaly [2](#)  
Organophosphate insecticides [269](#)  
Oronasal fistula, dental and oral cavity diseases and [147](#)  
Oropharyngeal disorders, localized, aspiration pneumonia and [91](#)  
Orthopedic lameness [55](#)  
Osmolality [341](#)  
Otitis externa, chronic  
    causes of [121–122](#)  
    perpetuating factors for [123](#)  
    predisposing factors for [122](#)  
Otitis media, otitis externa perpetuated by [123](#)  
Ovary, urogenital tumors and [239](#)  
Oxidants, hemolytic anemia triggered by [164](#)  
Oxidative injury, regenerative anemia and [167](#)  
Oxygen deprivation [252](#)

## **P**

Packed cell volume (PCV) *See* [Hematocrit](#)  
Pain, in neurologic examination [247](#)  
Pain assessment  
    acute [295](#)  
    chronic [296–297](#)  
Pain diagnosis [87–306](#)  
    acute pain assessment in [295](#)  
    acute pain preemptive scoring system in [296](#)  
    chronic pain assessment in [296–297](#)

Pallor [60–61](#)

Pancreatic disorders

- diarrhea caused by [148](#)
- exocrine [87–306](#)

Pancreatic lipase immunoreactivity (PLI) [348](#), [349b](#)

Pancreatitis [221–224](#)

- acute abdominal pain in [4](#)
- clinical findings of [221–222](#)
- clinicopathologic findings and [223–224](#)
- predisposing factors for [222–223](#)

Panophthalmitis, differential diagnosis for [191–192](#)

PaO<sub>2</sub>, evaluation of [313](#)

Papilledema [262](#)

Papules [62](#)

Paradoxical vestibular syndrome (cerebellar lesion) [254](#)

Parainfluenza and adenovirus type 2 [198](#)

Paralysis [62–63](#)

Paraneoplastic syndromes [230–232](#)

Parasites

- acute diarrhea caused by [23](#)
- dyspnea and [26](#)
- erythrocytic, in regenerative anemia [167](#)
- large intestinal disease and [154](#)
- otitis externa caused by [121](#)
- pruritus caused by [66](#)

Parasites protein-losing enteropathy and [156](#)

Parasitic blepharitis [259](#)

Parasitic canine ulcers [29](#)

Parasitic dermatoses [123–124](#)

Parasitic disease [20](#)

Parasitism [57–58](#)

Parathyroid hormone (PTH) [341](#)

Parathyroidism [141–142](#)

Paresis [62–63](#)

Paroxysmal disorders confused with epileptic seizures [248](#)

Parvovirus [197](#)

Patent ductus arteriosus, breed predispositions to [96](#)

Pathologic tremor [80–81](#)

Patient monitoring, GFAST triad for [306](#)

PCV *See* [Hematocrit](#)

- Penetrating trauma, AFS in [299](#)
- Penile disorders
  - acquired [287](#)
  - congenital [287–288](#)
- Penis, urogenital tumors and [238](#)
- People, phobia and [10](#)
- Perianal disease [155–156](#)
- Pericardial effusion [109–110](#)
- Pericardial site (PCS) views, in TFAST [304](#)
- Perineal inflammation, tenesmus and [80](#)
- Periodontal disease, dental and oral cavity diseases and [147](#)
- Peripheral blood [294](#)
- Peripheral cyanosis [21–22](#)
- Peripheral nerve
  - ataxia and [12](#)
  - tumors [248](#)
- Peripheral neuropathies [248–250](#)
  - fecal incontinence and [153](#)
- Peripheral vestibular disease [243](#), [253–254](#)
  - ataxia and [12](#)
  - head tilt and [37](#)
  - nystagmus and [58–59](#)
- Peritoneopericardial diaphragmatic hernia, breed predispositions to [97](#)
- Peritoneum, acute abdominal pain and [5](#)
- Persistent right aortic arch, breed predispositions to [97](#)
- Petechiae [63–64](#)
- pH [350](#)
  - evaluation of [313](#)
- Phagocytic cells [178](#)
- Pharyngeal disease [103–104](#)
  - dyspnea and [26](#)
  - stertor and [74](#)
- Phenol products [268](#)
- Pheochromocytoma [142](#)
- Phobias [10–11](#)
- Phosphorus (P) [342](#)
- Physical injury, erosions/ulcers and [119–120](#)
- Physiologic tremor [80](#)
- Piebaldism [44](#)
- Pigmentation [124–125](#), [258](#)
- Pinnal alopecia, canine and feline [7](#)

Pituitary-dependent hyperadrenocorticism (PDH) [328](#)  
Pituitary dwarfism [143](#)  
Pituitary tumors [244](#)  
Plant toxicoses [270–271](#)  
Plasma cells [177](#)  
Plasma oncotic pressure, decreased [113](#)  
Plasma osmotic pressure, reduced, edema and [27](#)  
Plasmacytoma [324](#)  
Platelet  
    consumption of [63](#)  
    destruction, increased [63](#)  
    production, decreased [63](#)  
    sequestration of [63](#)  
Platelet count [328](#), [342](#)  
Platelet dysfunction [170–171](#)  
Pleural effusion [110–111](#)  
    hyponatremia/hyperkalemia and [139](#)  
Pleural fluid examination, for chylothorax testing for cats and dogs [95](#)  
Pleural space disease, dyspnea and [26](#)  
PLI *See* [Pancreatic lipase immunoreactivity](#)  
Pneumonia [20](#)  
    aspiration [91–92](#)  
Pollakiuria [75](#)  
Polymerase chain reaction [343](#)  
Polymyopathy [103–104](#)  
Polyneuropathy [103–104](#)  
Polyuria [65](#)  
Portal hypertension [3](#)  
Portosystemic shunt [224–225](#)  
Portosystemic venous anomaly [219](#)  
Postganglionic lesion, assumption [42](#)  
Posthepatic biliary obstruction [48](#)  
Postinflammatory hyperpigmentation [43](#), [125](#)  
Postinterventional bleeding, AFS in [299–300](#)  
Postprandial hyperlipidemia [220](#)  
Postsinusoidal portal hypertension [3](#)  
Postural reactions, in neurologic examination [247](#)  
Posture, in neurologic examination [246–247](#)  
Potassium (K) [343](#)  
    hyponatremia/hyperkalemia and [139](#)  
Preganglionic lesion, assumption [41–42](#)

- Pregnancy, hyponatremia/hyperkalemia and [139](#)
- Prepuce
  - lesions of [35](#)
  - urogenital tumors and [238](#)
- Preputial disorders [288](#)
- Prerenal azotemia [9–10](#), [283–284](#)
- Pressure overload [97](#)
- Primarily conjunctival vessels [264](#)
- Primarily episcleral vessels [264](#)
- Primary hemostatic defects [169](#)
- Primary hepatic disease [216](#)
- Primary polydipsia, hyponatremia/hyperkalemia and [140](#)
- Progesterone-secreting tumors [129](#)
- Proliferative lymphadenopathies [56–57](#)
- Prolonged estrus [52](#)
- Propylene glycol [268](#)
- Prostate, urogenital tumors and [238](#)
- Prostatic abscess [290](#)
- Prostatic disease [277–278](#)
- Prostatitis
  - acute [290](#)
  - chronic [291](#)
- Protein [262](#), [350](#)
  - total [344](#)
- Protein-losing enteropathy [156](#)
  - small intestinal disease and [158](#)
- Proteinuria [278–279](#)
- Prothrombin time (PT) [328](#), [344](#)
- Prototheca* spp *See* [Algae](#)
- Protozoal arthritis [207](#)
- Protozoal diseases, polysystemic [193–194](#)
- Protozoal infection
  - fever caused by [32](#)
  - splenomegaly caused by [173](#)
- Protozoal myositis, muscle wasting and [15](#)
- Protozoal pericarditis [109](#)
- Protozoal scaling and crusting [70](#)
- Pruritus [66](#)
- Pseudohyperchloremia [318](#)
- Pseudohyperkalemia, hyponatremia/hyperkalemia and [140](#)
- Pseudorabies [198](#)



PT *See* [Prothrombin time](#)

PTH *See* [Parathyroid hormone](#)

Ptyalism (excessive salivation) [66–67](#)

Pulmonary central cyanosis [21](#)

Pulmonary disease [111–113](#)

Pulmonary edema [113–114](#)

- atrioventricular valve disease complicated by worsening [92](#)
- noncardiogenic [20](#)

Pulmonary fibrosis, chronic [20](#)

Pulmonary hemoptysis [41](#)

Pulmonary hypertension [101–102](#)

Pulmonary parenchymal disease [105](#)

- dyspnea and [26](#)

Pulmonary thromboembolism [114–115](#)

Pulmonic stenosis, breed predispositions to [96](#)

Pupillary dilation, Horner syndrome and [41–42](#)

Pustules [62](#)

Pyelonephritis, bacterial [279](#)

Pyoderma [125–126](#)

Pyogranulomatous disease, splenomegaly and [172](#)

Pyrethrin insecticides [269](#)

Pyrethroid insecticides [269](#)

Pythiosis [190](#)

- large intestinal disease and [155](#)

*Pythium insidiosum* *See* [Pythiosis](#)

## R

Rabies virus [198](#)

Ranula [150](#)

Recluse spiders *See* [Loxoscelidae](#)

Rectal disease, hematochezia and [39–40](#)

Rectal inflammation, tenesmus and [80](#)

Rectal obstruction, tenesmus and [79](#)

Rectal prolapse [154](#)

Red blood cell (RBC) count *See* [Erythrocyte count](#)

Red eye [264](#)

Reflux, vesicoureteral [289](#)

Regenerative anemia [60](#), [167–168](#)

Regurgitation [68–69](#)

Renal disease [279–285](#) *See also* [Glomerular disease](#)

- acute, causes of [283–284](#)

- chronic, causes of [284–285](#)
- diarrhea caused by [148](#)
- differential diagnosis for [280–281](#)
- differentiating acute from chronic [281](#)
- familial [279–280](#)
- hematuria and [40](#)
- toxins causing, in dogs and cats [281–283](#)
- Renal failure
  - acute [9–10](#), [281](#)
  - chronic [281](#)
- Renal glucosuria [280](#)
- Renal infarction, arterial thromboembolism and [90](#)
- Renal ischemia [283–284](#)
- Renal loss [319](#)
- Renal or urinary tract disease [139](#)
- Renal system, plants affecting [271](#)
- Renal toxins [253](#)
- Renal tubular acidosis [280](#)
- Renal tubular disease [280–281](#)
- Reproductive disorders [285–289](#)
  - differential diagnosis for
    - canine female and [285–286](#)
    - canine male and [286–287](#)
    - penis, prepuce, and testes [287–288](#)
  - drugs and metabolic disorders affecting, in male [288–289](#)
- Respiratory disease
  - halitosis and [36](#)
  - sneezing and [72–73](#)
- Respiratory toxicity [227](#)
- Respiratory tract
  - autoimmune disorders affecting [179](#)
  - disorders, lower [20–21](#), [104–105](#)
  - virus, upper [205](#)
- Restrictive cardiomyopathy, in cats [108](#)
- Retain nutrients impairment, muscle wasting and [15](#)
- Reticular interstitial patterns [112–113](#)
- Reticulocyte count [344–345](#)
- Retina [257](#)
- Retinal detachment [264–265](#)
- Retinal lesions, blindness and [13–14](#)
- Retinal visualization [263](#)

Reverse sneezing [70](#)  
Rheumatoid factor [177](#)  
Rickettsial arthritis [206](#)  
Rickettsial infection  
    fever caused by [32](#)  
    splenomegaly caused by [173](#)  
Rickettsiales, clinical importance in dogs and cats [184–185](#)  
Rickettsioses (spotted fever group Rickettsiae) [184](#)  
Right atrial and ventricular enlargement [94](#)  
Right-sided heart failure [3](#)  
Rocky Mountain spotted fever [194–195](#)  
Rotavirus [197](#)  
Round cell tumors [237](#)

## S

Sacral lesion [251](#)  
Sacral spinal cord disease [50–51](#)  
    fecal incontinence and [152–153](#)  
Salivary gland disease [156–157](#)  
Salivary mucocele [157](#)  
Salivary neoplasia [156–157](#)  
SAP *See* [Serum alkaline phosphatase](#)  
Sarcoma [232–233](#)  
    classification of soft tissue [232](#)  
    clinical findings for [232–233](#)  
    feline histiocytic [229](#)  
    histiocytic [229](#)  
Sarcoptic mange [123](#)  
Scaling and crusting [70–71](#)  
Sclera [261](#)  
Scraping [340](#)  
Scrotum lesions [35](#)  
Secondary hemostatic defects [169](#)  
Seizure [71–72](#)  
Self-injurious or self-directed compulsive disorder  
    canine [17](#)  
    feline [18](#)  
Sensation, in neurologic examination [247](#)  
Separation anxiety [11](#)  
Sepsis [195–196](#)  
Septic arthritis [206](#)

Septic exudates [3](#), [110](#)  
Serum alkaline phosphatase (SAP) [310](#)  
Serum chemistry  
    for chylothorax testing for cats and dogs [95](#)  
    diabetes mellitus and [132](#)  
Severe hypercholesterolemia [221](#)  
Severe hyperlipidemia [220–221](#)  
Sex-cord stromal tumors [239](#)  
SGOT *See* [Aspartate aminotransferase](#)  
SGPT *See* [Alanine aminotransferase](#)  
Sheath lesions [35](#)  
Shock [61](#)  
Short-bowel syndrome [159](#)  
Short estrus [52](#)  
Sialadenosis [157](#)  
Sialoadenitis [157](#)  
Sialocele [148](#)  
Silica [293](#)  
Sinus bradycardia [14](#)  
Sinus tachycardia [79](#)  
SIRS *See* [Systemic inflammatory response syndrome](#)  
Skin and subcutaneous tumors [237](#)  
SLE *See* [Systemic lupus erythematosus](#)  
Sleep disorders [248](#)  
Small bladder, stranguria in [75](#)  
Small bowel diarrhea [23–24](#)  
Small intestinal disease [157–159](#)  
    breed susceptibilities to, in dogs [159](#)  
    clinical findings for [157](#)  
    differential diagnosis for [157–159](#)  
    vomiting caused by [82](#)  
Small stature, failure to grow/thrive and [30–31](#)  
Snakes [271–272](#)  
Sneezing [72–74](#)  
Soaps and detergents [268](#)  
Sodium (Na) [345](#)  
    excessive loss of [318](#)  
    retention, edema and [27](#)  
Solid tumors [229](#)  
Specific gravity [349–350](#)  
Spiders [271–272](#)

Spinal cord  
  disease [250–251](#)  
  lesions [251](#)

Spinal reflexes, in neurologic examination [247](#)

Spleen, acute abdominal pain and [4–5](#)

Splenic infarction, arterial thromboembolism and [90](#)

Splenic mass [171](#)

Splenitis/splenomegaly  
  differential diagnosis for [171–173](#)  
  infectious causes of [173](#)

Spleno-Renal (SR) view, in AFAST [301](#)

Splenomegaly [171–173](#)

Spontaneous chronic corneal epithelial defects (SCCEDs) [260](#)

Spotted fever group Rickettsiae *See* [Rickettsioses](#)

Spurious, hypoglycemia and [138](#)

Starvation, muscle wasting and [15](#)

Steroid hormone precursor-secreting tumors [129](#)

Stertor [74](#)

Stomach disorders [159–162](#)

Stomatitis [76](#), [147](#)

Stranguria [75](#)

Stridor [74–75](#)

Struvite [292](#)

Stupor [77–78](#)

Subaortic stenosis, breed predispositions to [96](#)

Sublingual mucocele [150](#)

Sudden death, plants causing [271](#)

Superficial folliculitis [121](#)

Superficial pyoderma [125–126](#)

Suppurative cholangitis and cholangiohepatitis [210](#)

Surface ocular disease [261](#)

Surface ocular neoplasia [263](#)

Surface pyoderma [125](#)

Swab [340](#)

Symmetrical lupoid onychodystrophy [118](#)

Syncope [78–79](#), [248](#)

Systemic diseases [252–253](#)  
  colonic weakness and [19](#)  
  hypothermia and [47](#)  
  ocular manifestations of [261–263](#)  
  otitis externa and [122](#)

- with renal manifestations [284](#)
- sneezing and [73–74](#)
- Systemic histiocytosis [228](#), [323](#)
- Systemic hypertension [102–103](#), [263](#)
- Systemic hypotension, syncope and [78–79](#)
- Systemic infection [266–267](#)
- Systemic inflammatory response syndrome (SIRS) [195–196](#)
  - clinical findings of [196](#)
  - definitions in [195](#)
  - infectious causes of [195](#)
  - noninfectious causes of [195](#)
- Systemic lupus erythematosus [180–181](#)
  - diagnostic criteria in dogs and cats [180–181](#)
  - organs and tissues affected by [180](#)
- Systemic neuromuscular disorders, aspiration pneumonia and [91](#)
- Systolic murmurs [106](#)

## T

- T lymphocytes [178](#)
- T<sub>3</sub> (3,5,3'-triiodothyronine) concentration [347](#)
- T<sub>3</sub> suppression test [348](#)
- T<sub>4</sub>
  - free [347](#)
  - total [347](#)
- Tachyarrhythmias, sustained [98](#)
- Tachycardia, sinus [79](#), [115](#)
- Taurine deficiency [262](#)
- Tendons, trauma to, lameness caused by [56](#)
- Tenesmus [79–80](#)
- Testicular disorders [288](#)
- Tetanus [183](#)
- Tetralogy of Fallot, breed predispositions to [97](#)
- TFAST (thoracic FAST) [302](#)
  - clinical indications and applications of [304](#)
  - as extension of physical exam [302–306](#)
- Thoracic lesion, anterior [104](#)
- Thoracic radiographs, for chylothorax testing for cats and dogs [95](#)
- Thoracic spinal cord, ataxia and [12](#)
- Thoracocentesis fluid [346–347](#), [346b](#)
- Thoracolumbar lesion [251](#)

Thrombocyte count *See* [Platelet count](#)

Thrombocytopenia [63](#), [174](#)  
    nonregenerative anemia and [166–167](#)

Thrombopathia [63–64](#)

Thyroglobulin autoantibodies [176](#)

Thyroid disease [143–145](#)

Thyroid function tests [347–348](#)

Thyroid-releasing hormone (TRH) stimulation tests [347](#)

Thyroid-stimulating hormone (TSH)  
    concentration [347](#)  
    stimulation tests [347](#)

Thyroxine autoantibodies [176](#)

TIBC *See* [Total iron-binding capacity](#)

Tick paralysis [272](#)

Ticks [124](#)

TLI *See* [Trypsinogen-like immunoreactivity](#)

To-and-fro murmurs [107](#)

Tongue, disease of [150–151](#)

Tooth root abscess [147](#)

Total iron-binding capacity (TIBC) [336](#)

Total protein (TP) [344](#)

Total T<sub>4</sub> (thyroxine, tetraiodothyronine) [347](#)

Toxic hepatopathy [218](#)

Toxicology [87–306](#)

Toxicoses  
    chemical [268–269](#)  
    gagging and [34](#)  
    plant [270–271](#)  
    venomous bites and stings [271–272](#)

Toxins  
    hemolytic anemia triggered by [163–164](#)  
    renal, in dogs and cats [281–283](#)

Toxoplasmosis  
    canine [193](#)  
    feline [193](#)

Toxoplasmosis antibody titer [348](#)

Trachea disorders [104](#)

Transmissible venereal tumor (TVT) [324](#)

Transudates [3](#), [110](#)

Trauma

- dental and oral cavity diseases and [147](#)
- gagging and [34](#)
- lameness caused by [56](#)
- peripheral neuropathies and [248](#)
- tongue diseases and [150](#)
- urinary tract [291–292](#)
- Tremor [80–81](#)
- TRH *See* [Thyroid-releasing hormone](#)
- Tricuspid dysplasia, breed predispositions to [96](#)
- Trigeminal nerve (CN V)
  - deficit of [242](#)
  - paralysis [249](#)
- Triglycerides [348](#)
- Trochlear nerve (CN IV), deficit of [242](#)
- Trypanosoma cruzi* *See* [American trypanosomiasis](#)
- Trypsinogen-like immunoreactivity (TLI) [348](#)
- TSH *See* [Thyroid-stimulating hormone](#)
- Tumors
  - bone and joint [234](#)
  - epithelial [237](#), [239](#)
  - hematopoietic [235](#)
  - mast cell [235–236](#)
  - melanocytic [237](#)
  - oral cavity [236](#)
  - round cell [237](#), [322–324](#)
  - skin and subcutaneous [237](#)
  - urogenital [237–239](#)
- Turpentine [268](#)
- 2M myofiber autoantibodies [176](#)
- Tyrosinase deficiency [45](#)

**U**

- Ulcers
  - gastric [160](#)
  - of skin and mucous membranes [29–30](#), [175](#)
    - in cats [30](#), [120–121](#)
    - contact mucosal ulceration from calculus contact [151](#)
    - in dogs [29–30](#), [119–120](#)
- Ultrasonography, for chylothorax testing for cats and dogs [95](#)
- Undifferentiated hypotension, Vet BLUE differential diagnosis for [306](#)
- Upper airway disorders [19–20](#)



- Upper gastrointestinal inflammation [58](#)
- Upper respiratory tract viruses [205](#)
- Upper urinary tract infection [290](#)
- Urate/xanthine [292–293](#)
- Ureaplasmosis, cats [184](#)
- Uremia [150](#)
- Ureteral diseases [289](#)
  - acquired [289](#)
- Urethral obstruction [291](#)
- Urinalysis [349–352](#)
  - for chylothorax testing for cats and dogs [95](#)
  - diabetes mellitus and [132](#)
- Urinary bladder, urogenital tumors and [238](#)
- Urinary house soiling [48](#)
- Urinary retention [75–76](#)
- Urinary sediment examination [351–352](#)
- Urinary tract
  - function of, in neurologic examination [248](#)
  - trauma [291–292](#)
- Urinary tract infection (UTI) [290–292](#)
- Urine
  - cortisol/creatinine ratio [352](#)
  - discolored [81](#)
  - marking [50, 273](#)
  - protein/creatinine ratio [352](#)
- Urobilinogen [351](#)
- Urocystoliths [291](#)
- Urogenital disease [87–306](#)
  - acute abdomen caused by [161](#)
- Urogenital system, acute abdominal pain and [4](#)
- Urogenital tumors [237–239](#)
- Uroliths, canine [292–293](#)
- Urothelial toxicity [226](#)
- Urticaria [82](#)
- Urticaria pigmentosa [125](#)
- Uterus, urogenital tumors and [238](#)
- UTI *See* [Urinary tract infection](#)
- Uveal tract [261–262](#)
- Uveitis [266–267](#)

Vaccines, recommended core *vs.* noncore [196–197](#)

Vacuolar hepatopathy [217](#)

- canine [225](#)

Vagina and vulva, urogenital tumors and [238](#)

Vaginal discharge [293–294](#)

Vagus nerve (CN X), deficit of [242](#)

Vascular disease [252](#)

Vascular hepatic disease [218](#)

Vascular overload [113](#)

Vascular pattern [112](#)

Vascular permeability, increased [113](#)

Vascular purpura [64](#)

Vascular resistance, syncope and [78–79](#)

Vasculitis [118](#)

- in abdominal effusions and ascites [3](#)
- sneezing and [74](#)

Veins, enlarged [112](#)

Venomous bites and stings [271–272](#)

Venoms, anaphylaxis and [8](#)

Ventilation-perfusion mismatch [21](#)

Ventral cervical lesion [104](#)

Ventricular filling, restriction of [97](#)

Ventricular septal defect, breed predispositions to [96](#)

Vesicoureteral reflux [289](#)

Vestibular disease [253–254](#) *See also* [Central vestibular disease](#); [Idiopathic peripheral vestibular disease](#); [Peripheral vestibular disease](#)

Vestibulocochlear nerve (CN VIII), deficit of [242](#)

Vet BLUE lung ultrasound [304–305](#)

- differential diagnosis for patients with respiratory signs and dry lung [305–306](#)
- findings, in progression from most to least aerated/most consolidated [305](#)

Viral arthritis [207](#)

Viral colitis [154](#)

Viral infections

- fever caused by [32](#)
- splenomegaly caused by [173](#)

Viral pericarditis [109](#)

Viral scaling and crusting [71](#)

Viruses

- canine *See* [Canine viruses](#)
- feline *See* [Feline viruses](#)
- otitis externa caused by [122](#)

tongue diseases caused by [150](#)  
Vision loss, sudden *See* [Blindness](#)  
Visual message  
    interpretation failure [14](#)  
    transmission failure [14](#)  
Vitiligo [44](#)  
Vitreous [257](#)  
Vitreous humor lesions, blindness and [13](#)  
Volume-flow overload [97](#)  
Volume status, GFAST triad for [306](#)  
Vomiting [82–83, 92](#)  
von Willebrand disease [64](#)  
von Willebrand factor [353](#)

## W

Waardenburg-Klein syndrome [44](#)  
Water and ionic imbalances [252–253](#)  
Waxy casts [351](#)  
WBC *See* [White blood cell](#)  
Weakness [84–85](#)  
Weight gain *See* [Obesity](#)  
Weight loss *See* [Cachexia](#)  
West Nile virus [198](#)  
White blood cell (WBC) count [353](#)  
Widow spiders *See* [Latrodectus spp](#)  
Will not copulate [52](#)

## X

Xanthine [292–293](#)

## Y

Yeast, otitis externa perpetuated by [123](#)  
*Yersinia pestis* *See* [Feline plague](#)

## Z

Zinc [269](#)  
Zinc phosphate [269](#)  
Zollinger-Ellison syndrome *See* [Gastrinoma](#)  
Zygomycosis [190](#)

