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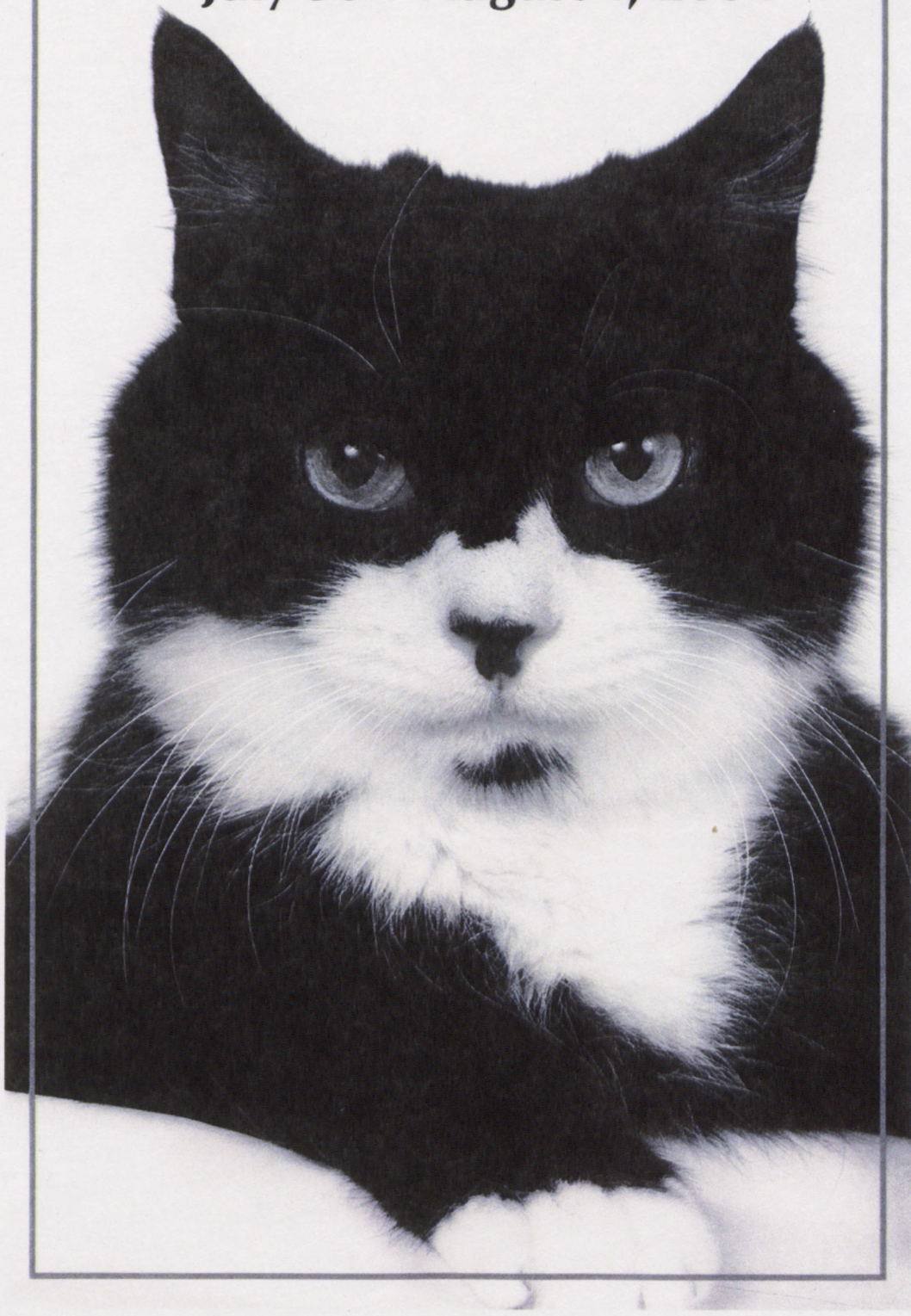
16th Annual Fred Scott Feline Symposium

July 30 – August 1, 2004



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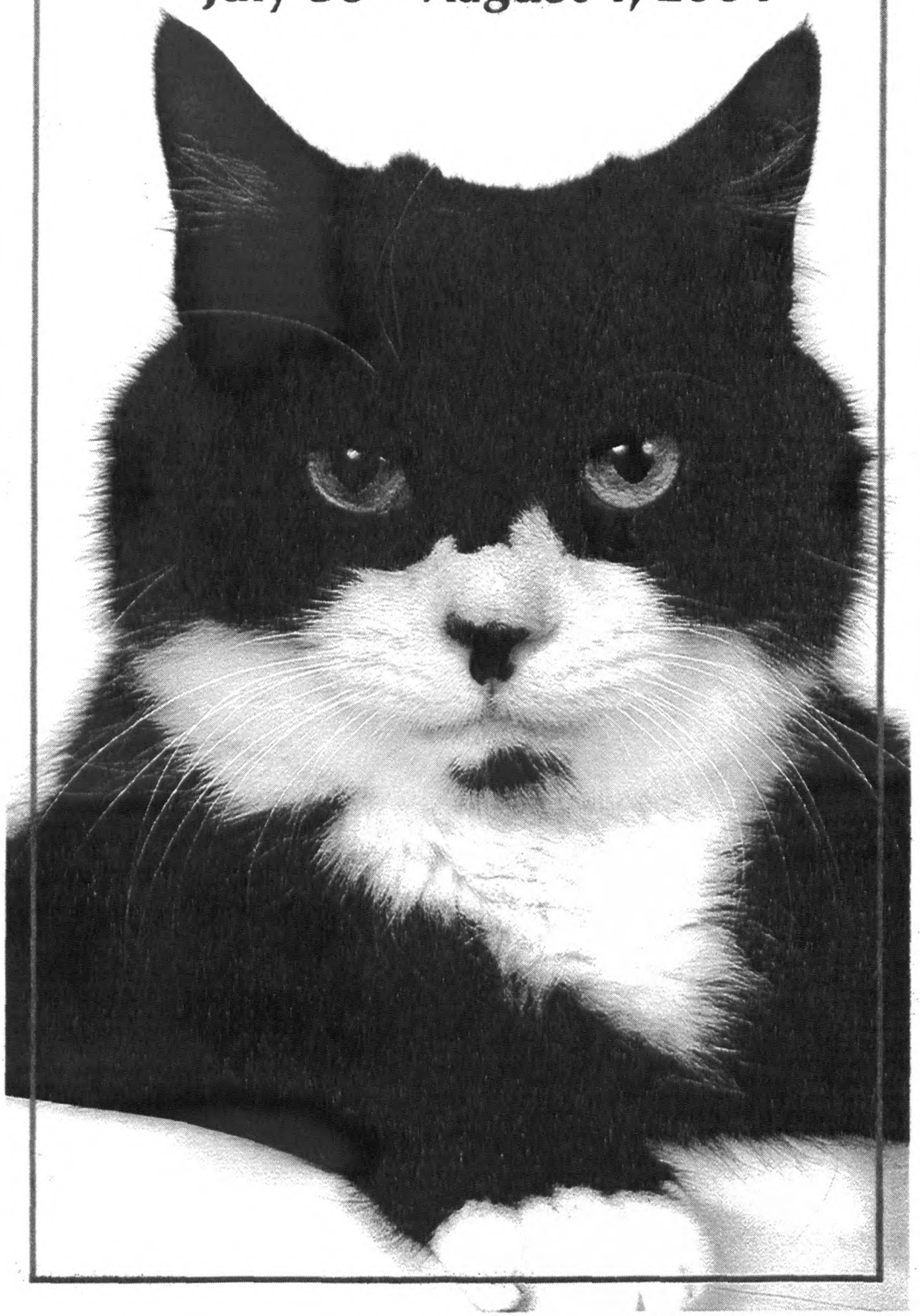

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Office of Continuing Education
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Information about the Cornell Feline Health Center at the College of Veterinary Medicine at Cornell University contact:

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Cornell University
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Phone	607-253-3414
Fax	607-253-3419
Website	www.vet.cornell.edu/public/fhc

General Information and Logistics

16th Annual Fred Scott Feline Symposium
July 30 - August 1, 2004

Course Overview

This year's 16th Annual Fred Scott Feline Symposium will educate and update veterinarians in the latest developments in feline gastroenterology, geriatric medicine, pharmacology, vaccine duration of immunity, and infectious diseases.

Accreditation and Continuing Education Credit

The College of Veterinary Medicine at Cornell University accredits this symposium for a maximum of 15.75 hours of continuing education credit. Each attendee should claim only those hours of credit that he/she actually spends in the educational lectures. You are asked to sign-in at the registration desk on the first day so that there is evidence of your attendance.

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It is important for the Cornell Office of Continuing Education, faculty, corporate sponsors, and exhibitors to receive your feedback. We ask that you complete the evaluation form and return it to the registration desk before you leave the symposium. The information you provide us is essential in the development of future educational programs. We welcome and encourage your comments on all aspects of this symposium.

Certificate of Participation

You will receive a certificate of participation, which will be available at the registration desk during lunch on Saturday, July 31. The certificate shows your attendance at the 16th Annual Fred Scott Feline Symposium.

Meals

Meal tickets are in the back of your nametag for:

- Lunch on Friday and Saturday. These lunch meal tickets are to be turned into the cafeteria cashier after you selected your lunch on Friday, and at the cafeteria entrance on Saturday.
- Lunch with a Speaker. If you signed up to have lunch with one of the speakers on Friday or Saturday please turn in your ticket to the staff member at the meeting room entrance.

Tours

If you registered to participate in a tour of the college, you will find an admittance ticket in the back of your nametag.

Course Materials

The course materials that are distributed during this symposium are under the auspices of the Office of Continuing Education at the College of Veterinary Medicine at Cornell University. Duplication of these materials is prohibited.

Disclaimer

The lectures offered during this symposium will include some discussion of off-label use and commercial products and/or services. The opinion and recommendations expressed by the faculty are their own.

Agenda

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16th Annual Fred Scott Feline Symposium
July 30 - August 1, 2004

Friday, July 30, 2004

7:30 - 8:00 am	Registration	James Law Lobby
	Continental Breakfast Sponsored by Schering-Plough Animal Health	Atrium
8:00 - 8:15	Welcome - James Richards, DVM	Lecture Hall I
	<u>Gastroenterology</u>	
	Kenneth Simpson, BVM&S, PhD	
8:15 - 9:15	Feline Gastroenterology - Part I	Lecture Hall I
9:15 - 9:30	Break	Atrium
9:30 -10:30	Feline Gastroenterology - Part II	Lecture Hall I
10:30 - 10:45	Break	Atrium
	<u>Pharmacology</u>	
	Lauren Trepanier, DVM, PhD	
10:45 - 11:45	Top 10 Potential Drug Interactions	Lecture Hall I
11:45 -1:15 pm	Lunch	Cafeteria
1:15 - 2:15	Transdermal Drugs	Lecture Hall I
2:15 - 2:30	Break	Atrium
2:30 - 3:30	Drug Dose Adjustment for Treating Resistant Bacterial Infections	Lecture Hall I
3:30 - 3:45	Break	Atrium
3:45 - 5:00	Treating Resistant Bacterial Infections	Lecture Hall I
6:00 - 9:00	Annual Picnic - Memorial Room Sponsored by Heska Corporation	Willard Straight

Saturday, July 31, 2004

7:30 - 8:00 am	Continental Breakfast Sponsored by Schering-Plough Animal Health	Atrium
	<u>Geriatrics</u>	
	Danielle Gunn-Moore, BVM&S, PhD	
8:00 - 9:00	Considering the Older Cat - Part I	Lecture Hall I
9:00 - 9:15	Break	Atrium
9:15 - 10:15	Considering the Older Cat - Part II	Lecture Hall I
10:15 - 10:30	Break	Atrium
10:30 - 11:30	Cognitive Dysfunction Syndrome	Lecture Hall I

11:30 - 1:00 pm	Lunch Sponsored by IDEXX Laboratories	Cafeteria
	Vaccine Duration of Immunity & Infectious Diseases	
1:00 - 2:00	Vaccine Duration of Immunity David Haworth, DVM, PhD Sponsored by Pfizer Animal Health	Lecture Hall I
2:00 - 2:15	Break	Atrium
2:15 - 3:15	Feline Mycobacterial Disease Danielle Gunn-Moore, BVM&S, PhD	Lecture Hall I
3:15 - 3:30	Break	Atrium
3:30 - 5:00	Newly Emerging Infectious Diseases Danielle Gunn-Moore, BVM&S, PhD	Lecture Hall I
5:00	Free time to explore Ithaca	

Sunday, August 1, 2004

8:00 - 8:30 am	Continental Breakfast Sponsored by Schering-Plough Animal Health	Atrium
8:30 - 11:45	Feline Hematology Dry Lab Tracy Stokol, BVSc, PhD	Wiswall Dry Lab
8:30 - 10:00 am	Early morning sessions	
1.	Lecture - Feline Case Studies in Internal Medicine Danielle Gunn-Moore, BVM&S, PhD	Lecture Hall I
2.	Electronic Resources for the Practitioner Susanne Whitaker, MLS, AHIP *(repeated at 10:15 am)*	Library
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Danièlle A. Gunn-Moore BSc, BVM&S, PhD, ILTM, MACVSc, MRCVS, RCVS Specialist in Feline Medicine

Danièlle Gunn-Moore is a RCVS Specialist in Feline Medicine. She graduated from the R(D)SVS, Edinburgh, in 1991. After a year in small animal practice she joined The Feline Centre at the University of Bristol as the Feline Advisory Bureau Scholar. After that she held the Duphar Feline Fellowship, then completed a PhD study into Feline Infectious Peritonitis. After a short period as Lecturer in Veterinary Pathology at the University of Bristol, she returned to Edinburgh, where she is the Nestlé Purina Senior Lecturer in Feline Medicine. She is the Head of the Feline Clinic, and is interested in all aspects of feline medicine.

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J. David Haworth, DVM, PhD

Dr. Haworth completed his undergraduate work at the College of William & Mary in Virginia, then went on to receive both his PhD and DVM at Colorado State University. His doctoral research focused on the interaction of the immune system and female reproductive cycles. Following his PhD he was a post-doctoral fellow in the Oncology department at Colorado State, where he investigated some observed interactions between infection and extended remissions in osteosarcoma cases. After CSU, Dr. Haworth practiced in a small animal clinic and an emergency referral hospital in Spokane, Washington. In 2000, he moved to Groton, Connecticut to work in the Veterinary Medicine Research & Development division of Pfizer Animal Health. Last year, following the Pfizer acquisition of Pharmacia, the entire R & D division, including Dr. Haworth, relocated to Kalamazoo, MI, where he presently resides. For relaxation, David enjoys hiking, swimming, martial arts and spending time with his wife, Claudia their two children, Connor and Alaina.

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Kenneth W. Simpson, BVM&S, PhD, MRCVS, Dipl. ACVIM, Dipl. EVCIM-CA

Dr. Simpson graduated from the University of Edinburgh (BVM&S) in 1984 and is a Diplomate of the American and European Colleges of Veterinary Internal Medicine. He is an Associate Professor of Medicine at Cornell University's College of Veterinary Medicine with clinical and research interests in internal medicine and gastroenterology.

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Tracy Stokol, BVSc, PhD, Dipl. ACVP

Dr. Tracy Stokol graduated in 1987 as a Bachelor of Veterinary Science from the University of Melbourne, Australia. After graduation, she worked as a veterinary associate in small animal practice in the Melbourne Metropolitan area, before returning to the University of Melbourne to begin a PhD under the supervision of Dr. Bruce Parry. Dr. Stokol successfully defended her thesis "von Willebrand Disease in dogs in Australia" in 1993, and that year she came to Cornell University as an instructor in Clinical Pathology. She achieved board certification in Clinical Pathology in 1995 and remained at Cornell University until 2000. At this time, she moved to Boston and took up a position as a post-doctoral fellow in the Department of Pathology at Brigham and Women's Hospital, Harvard University. However, she could not stay away from beautiful Ithaca and returned to the Department of Population Medicine and Diagnostic Sciences in May 2002. Dr. Stokol's research interests encompass hemostatic and hematopoietic diseases in animals and basic research into mechanisms of metastasis in cancer.

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Lauren Trepanier, DVM, PhD, DACVIM, DACVCP

Lauren Trepanier graduated with distinction from Cornell University's College of Veterinary Medicine in 1986. She survived an internship and residency in Small Animal Internal Medicine at the Animal Medical Center in New York, then spent two years as Chief of Community Practice at Cornell University. Dr. Trepanier completed a PhD in Pharmacology in 1997 at Cornell, and moved to the University of Wisconsin-Madison. She is an Associate Professor at the University of Wisconsin School of Veterinary Medicine, where she manages internal medicine referral cases, provides therapeutic drug monitoring, and conducts research on the metabolic basis of adverse drug interactions. She is board certified in both Internal Medicine and Veterinary Clinical Pharmacology.

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Susanne K. Whitaker, MLS, AHIP

After receiving an undergraduate degree in biology, Suzanne Whitaker attended the Masters in Library Science program at Case Western Reserve University, which offered a specialization in medical librarianship. This lead to a position in reference services at the Yale Medical Library. Subsequently, she became the medical librarian at Hartford Hospital in Connecticut for 4 years. Since moving to Ithaca, she has been affiliated with the Flower-Sprecher Veterinary Library for nearly 27 years, as reference librarian, then as the director for 20 years, and currently as reference/collection development librarian. Susanne has been an active member of the Medical Library Association and is Veterinary Medical Libraries Section, serving as section chair in 1984/1985 and currently as chair of the Public Relations Committee. She is also a member of the Academy of Health Information Professionals. Thus, Susanne has a solid foundation in health sciences librarianship and c experience with veterinary medical information resources.

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James R. Richards, DVM

Dr. Jim Richards is the current Director of the Cornell Feline Health Center at the Cornell University College of Veterinary Medicine (CUCVM) and has held this position since 1997. In addition, he is the President-Elect of the American Association of Feline Practitioners (AAFP), Chair of the Education/Communication Subgroup, AVMA/AAHA/VCS Vaccine-Associated Feline Sarcoma Task Force, Editor-in-Chief of *CatWatch*, a publication of CUCVM, a faculty advisor for the student chapter of the AAFP, and a faculty advisor for the CUCVM Pet Loss Support Hotline.

Dr. Richards received his DVM from Ohio State University College of Veterinary Medicine in 1979. Prior to receiving his DVM he was a graduate student and teaching associate in the Department of Mathematics at Ohio State University and earned his Bachelor of Arts in Mathematics from Berea College in 1970.

Dr. Richards' current teaching responsibilities, at the Cornell College of Veterinary Medicine, include teaching a section on vaccine efficacy and adverse reactions, a bi-monthly feline health seminar presented to community practice service students, seminars on euthanasia, pet loss support, and feline health topics.

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There were no pages

in this section

The Vomiting Cat

Kenneth W. Simpson
BVM&S, PhD, DipACVIM, DipECVIM-CA
College of Veterinary Medicine
Cornell University
Ithaca, NY 14853

The clinical importance of vomiting stems from its association with a large, and varied group of diseases, and the potentially life threatening consequences of vomiting per se, such as aspiration pneumonia, fluid and electrolyte depletion, acid-base derangement and oesophagitis. Patient management should always be aimed at determining the medical significance of vomiting and detecting and treating the cause of vomiting. Where the cause is undetermined it is necessary to adopt a rational approach to controlling emesis.

Causes of Vomiting

There are so many potential causes of vomiting that it is often easiest to think in broad terms initially i.e. gastric, intestinal, intra-abdominal non-GIT, metabolic-endocrine, drugs, toxins, dietary, neurologic, infectious diseases and consider more specific causes when vomiting is localized to one of these groups.

Gastric	Gastritis, Ulceration, Neoplasia, Outflow obstruction, Foreign bodies, Motility / functional disorders	
Intestinal	Inflammatory Bowel Disease, Neoplasia, Foreign bodies, Intussusception,Functional disorders	
Intra-abdominal non-GIT		
	Pancreas	Pancreatitis, Pancreatic Neoplasia
	Liver	Hepatitis, Cholangiohepatitis, Biliary Obstruction
	Genitourinary	Nephritis, Pyelonephritis, Nephrolithiasis, Urinary obstruction, Pyomertra, Peritonitis
Metabolic / Endocrine	Uremia, Hperthyroidism, Diabetic Ketoacidosis, Hepatic Encephalopathy, Hypoadrenocorticism, Hypercalcaemia, Septicemia	
Drugs	Xylazine, Digoxin, Erythromycin, Chemotherapy,	
Toxins	Strychnine, Ethylene Glycol, Lead	
Dietary	Indiscretion, Intolerance, Allergy	
Neurologic	Vestibular disease, Encephalitis, Neoplasia, Raised intra-cranial pressure	
Infectious	Panleukopenia, FIP, Salmonella, Helicobacter?	
Parasitic	Ollulanus, Heartworm	

Patient evaluation and diagnostic approach

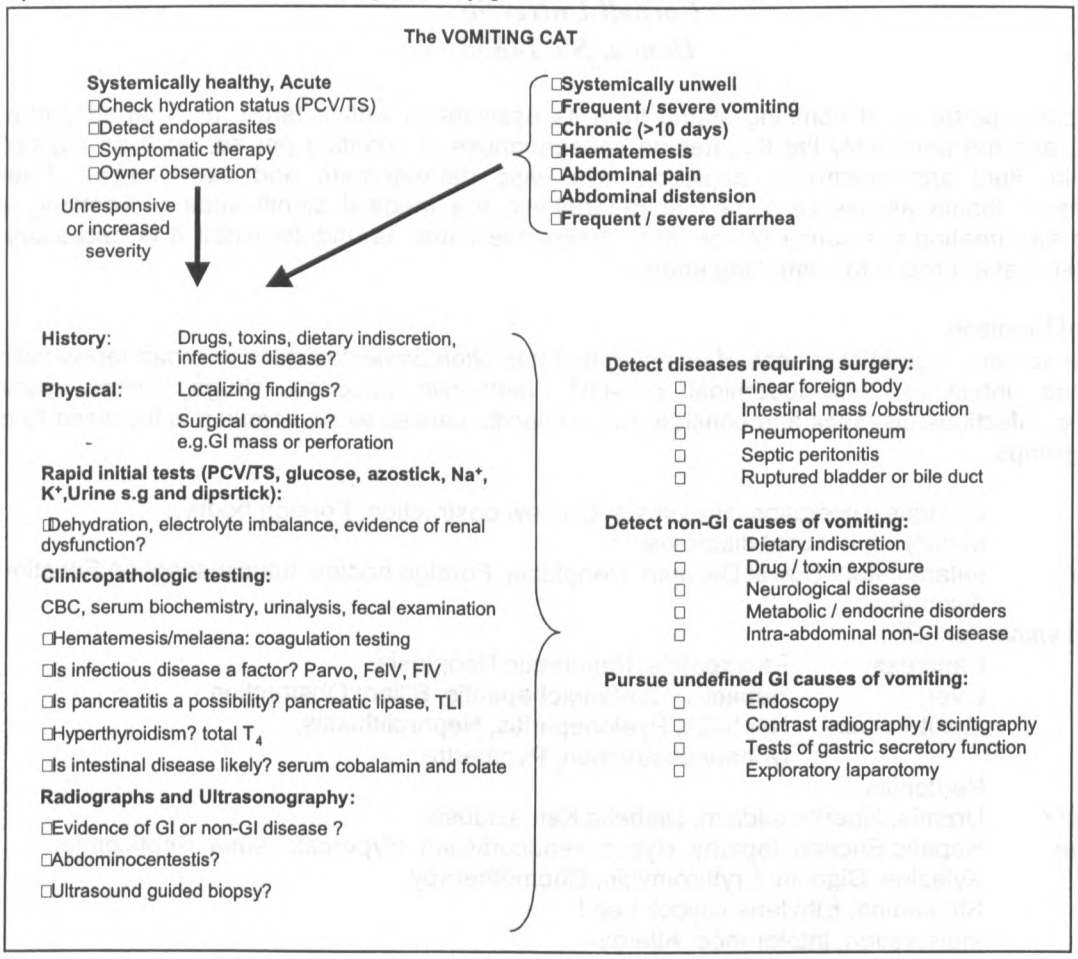
The initial plan for vomiting animals is to separate those whose problems are acute and self-limiting from those who require more thorough investigation and treatment.

Acute vomiting and systemically well

If vomiting is acute and the cat is systemically well, with no historical or physical "red flags" further diagnostic testing is usually not warranted as vomiting often resolves on its own, or after symptomatic therapy. If there is any doubt about hydration status a minimum data base consisting of a microhematocrit and total protein can be performed to more objectively evaluate hydration status (see below). In kittens a fecal examination to detect endoparasites may also be performed.

Chronic vomiting or systemically unwell

If the cat is systemically unwell, vomiting for more than 10 days, or has hematemesis, bloody diarrhea or localizing signs such as abdominal pain or jaundice a more aggressive work-up is necessary to define the nature of the problem. The diagnostic approach described below should enable the clinician to detect the majority of causes of vomiting. The emphasis is on efficiently identifying conditions that require surgical intervention e.g. septic peritonitis, and ruling out non-gastrointestinal causes of vomiting, before proceeding to more specialized or invasive diagnostic procedures aimed at detecting primary gastric and intestinal disorders.



Most non-gastrointestinal causes of vomiting, and gastrointestinal causes such as focal masses or GI perforation, are usually detected, or ruled out, by taking a detailed history, performing a thorough physical examination, routine laboratory tests (CBC, profile, UA, Fecal and T4, FeIV, FIV, pancreatic lipase/TLI, cobalamin and folate where indicated) and abdominal radiographs. Abdominal ultrasound is useful for detecting pancreatic lesions, parenchymal abnormalities, GI thickening and sampling masses. If these tests are negative or show abnormalities compatible with primary gastric or intestinal disease, further workup for gastrointestinal disease is indicated e.g. endoscopy, contrast radiography, exploratory laparotomy.

Clinicopathologic testing

Clinicopathologic testing is used to detect the causes and consequences of vomiting. It is very important that blood and urine samples submitted for clinicopathological analysis are obtained prior to treatment.

Rapid initial tests "a minimum database" are recommended for vomiting animals that are suspected of being dehydrated.. These rapid tests are the measurement of microhaematocrit (PCV), total solids

(TS), blood glucose, blood urea nitrogen and a urine specific gravity and dipstick. Plasma concentrations of sodium and potassium should also be determined where possible. Bold and urine samples should be evaluated before treatment. These simple tests provide valuable information that helps to determine cause (e.g. azotaemia and unconcentrated urine suggests renal disease) and guide initial management pending more definitive testing.

A complete blood count may yield abnormalities such as anemia (regenerative, non-regenerative), eythrocyte microcytosis, macrocytosis, basophilic stippling or Heinz bodies and leukocytosis, leukopaenia, eosinophilia or thrombocytosis that help to identify the cause vomiting. e.g. erythrocyte macrocytosis is relatively common in FeIV infected cats, whereas eosiniophilia may indicate hypereosinophilic syndrome or eosinophilic enteritis.

The serum biochemical profile should be evaluated for elevations in creatinine, urea, calcium, potassium, glucose, liver enzymes, bilirubin, cholesterol, triglycerides and globulin, and decreases in sodium, calcium, urea or albumin that are associated with non-GI causes of vomiting. Panhypoproteinemia that is not related to blood loss suggests a protein losing enteropathy, which in cats is most often associated with severe IBD or lymphoma. Determination of acid-base status by measurement of total CO_2 or venous blood gas analysis enables the presence of metabolic acidosis or alkalosis to be detected. This facilitates optimal supportive care and may also help to determine the cause of vomiting e.g.metabolic alkalosis accompanied by hypochloremia, hypokalaemia and an acid urine (so called paradoxic aciduria) is highly suggestive of gastric outflow, or upper GI, obstruction. Venous blood gases and plasma osmolality are often determined in animals suspected of ethylene glycol ingestion, with the findings of metabolic acidosis and a high osmolal gap (calculated by subtracting calculated from measured osmolality) supportive of ingestion. Urine should be evaluated for specific gravity, pH, glucose, casts, crystals and bacteria. The finding of white cell casts in the urine may be the only laboratory evidence that pyelonephritis is the cause of vomiting.

Additional clinicopathologic tests are required to detect hypoadrenocorticism (ACTH stimulation- extremely rare in cats), liver dysfunction (pre- and post prandial bile acids), hyperthyroisim (T_4), pancreatitis (pancreas specific lipase and trypsin-like immunoreactivity), and intestinal disease (serum cobalamin and folate- see diarrhea notes). When vomiting is accompanied by hematemesis or melena coagulation testing is indicated. Coagulation testing is also indicated in patients with acute abdomen to detect DIC, and in those with chronic vomiting and diarrhea, or weight loss to detect Vitamin K malabsorption. Infectious diseases associated with vomiting and diarrhea require fecal examination (giardia, endoparasites, Salmonella, Campylobacter and Parvovirus (ELISA) or serologic testing (FeIV, FIV) for diagnosis.

Diagnostic imaging

Diagnostic imaging provides information that complements and extends clinicopathologic testing. The primary diagnostic imaging modalities employed to investigate vomiting are abdominal radiographs and abdominal ultrasonography. Radiographs are the test of choice for the initial evaluation of vomiting and acute abdomen (abdominal pain). They provide information on gastric position and contents, size of the liver, kidneys and spleen, and may identify foreign bodies, GI obstruction, intussusception, peritonitis and changes suggestive of pancreatitis. Where radiography is inconclusive ultrasound is employed to achieve a more accurate diagnosis. Ultrasonography is especially useful for detecting and localizing thickenings of the intestinal tract, lymphadenopathy, abdominal masses, radioluscent foreign bodies, and changes in the size and echogenicty of the pancreas, liver, kidneys or spleen. Ultrasonography also enables the detection of low volume abdominal effusions and detailed investigation of the abdomen of patients with large volume effusions and "white radiographs". Ultrasound guided aspiration is employed for sampling peritoneal fluid or parechymal abnormalities. Ultrasound guided needle biopsy is also useful for non-invasive sampling of abdominal organs and parenchymal abnormalities.

Further investigation of gastrointestinal causes of vomiting

The above approach, employing a combination of signalment, history, physical examination, clinicopathologic testing and diagnostic imaging, should enable the accurate diagnosis of vomiting patients requiring urgent surgery, and non-gastrointestinal causes of vomiting. The diagnosis of primary gastric or intestinal inflammation, ulceration or neoplasia, delayed gastric emptying, and functional disorders of the stomach and intestine requires further work-up. This usually entails endoscopy or surgery to visualize and biopsy the stomach and intestines. The choice of an

endoscopic or surgical approach depends on the results of clinicopathologic testing and diagnostic imaging, the most likely cause of vomiting, and the availability of endoscopic or surgical facilities. For example a cat with chronic vomiting with normal clinicopathologic and imaging results has a high likelihood of having inflammatory bowel disease and would be a good candidate for endoscopic visualization and biopsy of the stomach and small intestine. When endoscopy is not available a surgical biopsy could achieve the same result, but with higher morbidity. Where the patient is a vomiting cat with abnormal liver enzymes, thickened intestines and an enlarged pancreas then surgical biopsy is the most efficient means of determining the nature of disease e.g. cholangiohepatitis, pancreatitis and GI lymphoma.

Evaluation of gastric emptying

Delayed gastric emptying is caused by outflow obstruction or defective propulsion and is usually suspected by the vomiting of food >12-16hrs after ingestion. Other signs include abdominal discomfort, distention, bloating and intermittent anorexia. Outflow obstruction can be caused by polyps, foreign bodies, tumours, pyloric hypertrophy or stenosis, granulomata and extraluminal masses such as pancreatic tumours. Defective propulsion may result from primary gastric diseases such as gastritis, ulceration, neoplasia, and parasitism or non-gastric disorders such as stress, trauma, peritonitis, pancreatitis, infectious enteritis, electrolyte (espy hypokalemia) and metabolic derangements, drugs and surgery. The finding of hypochloremia, hypokalemia, and metabolic alkalosis, ± aciduria, should raise the suspicion of an upper GI obstruction or perhaps gastrinoma.
The ability of ultrasonography and endoscopy to detect obstructive, inflammatory and neoplastic diseases of the GIT has meant that contrast radiographic procedures are often restricted to the investigation of delayed gastric emptying associated with defective propulsion and "functional" intestinal disorders. However, if endoscopy and ultrasonography are not available contrast radiographic procedures can provide useful information on gastric and intestinal patency and morphology, with surgical biopsy performed to achieve a definitive diagnosis. Procedures used to evaluate delayed gastric emptying include barium contrast (liquid or mixed with food), barium impregnated polyspheres (BIPS), nuclear scintigraphy, and the ^{13}C-octanoate breath test. Radiography: plain films confirm delayed gastric emptying if retention of food or fluid >10-15hrs after a meal. Contrast: liquid barium (30%w/v, 12-16ml/kg via stomach tube) -the stomach should empty within 15-60 min in cats), barium meal (normal < 10-15hrs) or barium polyspheres. These tests are probably best used to accurately determine the efficacy of prokinetic drugs in patients with delayed gastric emptying. Remember that endoscopy is best for confirming gastric outflow obstruction and gastric and duodenal causes of decreased propulsion (e.g. ulcers, gastritis). Measurement of gastric pH and serum gastrin may help to determine the cause of gastric ulceration or mucosal abnormalities.

Strategies for managing some common causes of persistent vomiting

Uremia

Vomiting in uremia is mediated via the effects of uremic toxins on the CRTZ and afferent inputs from the inflamed stomach. Control of vomiting is centered around ameliorating uremia with fluid therapy, antagonising the effects of uremic toxins on the CRTZ and limiting afferent input from the inflamed gut. Uremic vomiting in cats is often most amenable to fluid therapy and treatment aimed at controlling the the peripheral effects of uremia i.e. an H2 antagonist (e.g. famotidine 0.5-1.0mg/kg SID-BID) and mucosal protectants (sucralfate 0.25-1g PO TID). This contrasts wth dogs where reducing CRTZ stimulation with a D2- dopaminergic antagonist such as metoclopramide (0.2-0.4mg/kg SC. IM, PO QID or 1mg/kg/24hrs continuous IV infusion) is necessary to control vomiting. In cats D-2 dopaminergic anatgonists may be ineffective in reducing CRTZ stimulation. Metoclopramide is avoided in patients receiving dopamine to promote diuresis, and is considered a less effective antiemetic in cats than alpha adrenergic antagonists. Cats, or dogs, with vomiting which is refractory to initial therapy for uremic gastritis may benefit from an a2-adrenergic antagonist such as chlorpromazine (0.2-0.4mg/kg TID SC) or prochlorperazine (0.5mkg/kg TID SC IM) - ensure adequate hydration.

Gastritis / Gastric ulceration

Vomiting in patients with acute gastritis or gastric ulceration is managed by providing adequate fluid therapy, restricting oral intake and limiting afferent input from the inflamed gut by decreasing gastric acid secretion (e.g. H2 antagonists) and providing mucosal protection (e.g. sucralfate). A PGE analog (misoprostol 3-5µg/kg PO TID) may be beneficial in dogs where persistent vomiting is associated with NSAID administration but has not been evaluated in cats. Where ulceration is severe and vomiting is not adequately controlled metoclopramide (dog) or chlorpromazine/ prochlorperazine can be used as an adjunct in the short term.

In patients with severe or persistent ulceration more complete inhibition of gastric acid secretion can be achieved with the H/K ATPase inhibitor - omeprazole (0.2-0.7 mg/kg SID PO). This drug may be particularly effective in dogs with persistent GI ulceration, excessive secretion of gastric acid or recurrent esophagitis The safety and efficacy of omeprazole in cats has not been widely reported.

Mast cell tumors may cause vomiting via the central effects of histamine on the CRTZ (dogs) and the peripheral effects of histamine on gastric acid secretion (with resultant hyperacidity and ulceration). Treatment of mastocytosis with H1 and H2 histamine antagonists (e.g. diphenhydramine and famotidine) should reduce the effects of histamine. Omeprazole may be useful to limit acid secretion in patients refractory to H2 antagonists. Corticosteroids are used to decrease tumor size and release of histamine.

Where chronic intermittent vomiting is associated with gastritis a diet which is high in carbohydrate, restricted in fat and moderate in protein may facilitate gastric emptying and digestion. Limited antigen/hydrolyzed antigen diets can also be employed in patients where gastritis and vomiting are thought to be due to food allergy.

The role of *Helicobacter spp* in chronic vomiting in the cat is the subject of much speculation and debate. Where chronic intermittent vomiting and gastritis are associated with the presence of *Helicobacter spp.* - a combination of antibiotics (amoxicillin, metronidazole and clartithromycin) has been shown to eradicate Helicobacter like organismsin cats with *H. pylori* infecetion (see notes on Helicobacter).
The management of gastritis associated with delayed gastric emptying is centered around diet and prokinetic agents (see below)

Treatment of gastric emptying disorders is directed at the underlying cause- e.g. surgery for pyloric outflow obstn.; antacids, mucosal protectants and/or antibiotics for gastritis. In non-obstructive situations gastric emptying may be enhanced by dietary modification to facilitate gastric emptying (small amounts of semi-liquid, protein and fat restricted diets fed at frequent intervals e.g. intestinal diets blended with water and mixed with an equal volume of boiled rice may also be of benefit) and prokinetic agents such as metoclopramide (0.2-0.5mg/kg PO SC TID), or cisapride (0.1-0.5mg/kg PO TID). Erythromycin is effective in dogs but has not been evaluated in cats (dog- 0.5-1.0mg/kg PO TID). Ranitidine and nizatidine, which have OP like activity, may also be effective in promoting gastric emptying in cats.

Idiopathic inflammatory bowel disease

Lymphoplasmacytic enteritis

Lymphoplasmacytic enteritis is the most common type of inflammatory bowel disease in dogs and cats. It is characterized by the accumulation of excessive numbers of lymphocytes and plasma cells in the lamina propria of the intestine. The degree of cellular accumulation is variable and is subjectively categorised as mild, moderate and severe. Moderate to severe lymphoplasmacytic enteritis is often associated with a protein losing enteropathy. A severe form of the condition has been reported in Basenjis. The extent of inflammation appears variable and ranges from the duodenum to the small and large bowel.

Clinical findings

Chronic small bowel diarrhea accompanied by weight loss or vomiting are the most frequent findings in dogs whereas vomiting is the most common clinical sign in cats. Vomitus often contains bile. Hairballs are frequent in cats. Other findings include changes in appetite, excessive borborygmi and abdominal discomfort. The severity of disease is variable, ranging from intermittent diarrhoea and vomiting in mild cases to intractable small bowel diarrhea, inappettance and weight loss in severe ones. The severity of the disease is thought to reflect the degree of cellular infiltrate. Physical findings range from normal to thickened intestines ± mesenteric lymphadenopathy, marked weight loss, and ascites or oedema in animals with severe protein losing enteropathy.

Diagnosis:

A diagnosis of idiopathic lymphoplasmacytic enteritis is made by excluding systemic, parasitic, infectious, pancreatic and structural causes of chronic diarrhea and demonstrating excessive numbers of lymphocytes and plasma cells in intestinal biopsies.

Treatment

Treatment of IBD is usually based on dietary modification, antibiotics and immunosuppression. Treatment is to some extent based on the severity of the disease. Mild to moderate intestinal inflammation may be associated with dietary sensitivity or intolerance, or potentially idiopathic small intestinal bacterial overgrowth. A therapeutic dietary trial can be performed with either:1) a highly digestible diet which is restricted in fat and gluten-free ,2) a diet limited to a single novel protein source or3) a diet containing protein hydrolysate, to determine if dietary sensitivity or intolerance are present. A response is usually observed within 2 -3wks. Similarly a therapeutic trial (21days) with Tylosin (10mg/kg PO TID), metronidazole (15mg/kg PO BID) or oxytetracycline (10-20mg/kg PO TID) for antibiotic responsive enteropathy /small intestinal bacterial overgrowth may be warranted. In patients who fail these trials and in those with moderate to severe infiltrates, or hypoproteinaemia the administration of immunosuppressive agents is usually required to achieve a response. Oral prednisolone (1-2mg/kg PO BID) is the initial drug of choice. It is usually administered at an immunosuppressive dose for 2-3 wks and then decreased by 50% every 2-3wks, and then continued on an alternate day basis for 2-3 months. If clinical response is poor or the adverse effects of prednisolone predominate azathioprine can be added to the regimen. In dogs it is usually given every day (2mg/kg PO SID) for five days and then on alternate days to prednisolone. Cats are more sensitive to azathioprine (0.3mg/kg PO SID) and may be better managed with chlorambucil (6mg/m2 PO PO EOD (@2mg/5.3kg cat) and prednisone (5mg PO /cat/day). Supplemental cobalamin (1ml SC q 2-3wks) and folate / B complex vitamins should also be given if serum concentrations are low. Metronidazole (15mg/kg PO BID 10-14d then SID 10-14d) can also be used in conjunction with corticosteroids and has effects on bacteria and possibly the immune system. Successful treatment is accompanied by a decrease in clinical signs and an increase in plasma proteins. Once a patient has had 2-3 months remission from signs it may be possible to gradually withdraw immunosuppressive therapy. If signs recur daily medication is continued until signs resolve then gradually reduced. In patients who respond poorly to therapy or relapse after an initial response lymphoma should be ruled out.

Prognosis

The prognosis for lymphoplasmacytic enteritis is variable and depends on its severity. Many patients require prolonged treatment with glucocorticoids and diet. As no accurate criteria exist for predicting response it is wise to give a guarded prognosis.

Strategies to control persistent vomiting of undetermined etiology

Symptomatic fluid therapy, diet restriction or modification and antiemetics to control vomiting is indicated where vomiting is frequent or severe enough to cause derangements of fluid, electrolyte and acid base balance. Antiemetics should not be given if intestinal obstruction or ingestion of toxic substance is suspected. Antiemetic selection in patients with unknown causes of vomiting is based on a best guess, least harmful approach. Alpha -2 adrenergic antagonists (prochlorperazine, chlorpromazine-) and D2 -dopaminergic antagonists (metoclopramide) are suggested first and second choices.

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Top Ten Potential Drug Interactions

Top Ten Potential Drug Interactions

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Polypharmacy (using multiple drugs at the same time in the same patient) is sometimes unavoidable in patients with multiple acute and/or chronic medical problems, particularly older patients. However, the risk of drug interactions (and adverse effects), at least in humans, multiplies as the number of administered drugs increases. Interactions can occur during IV drug administration, during oral absorption, at the target site (either antagonistic or synergistic effects), or during hepatic or renal elimination. Any of these interactions may lead to loss of efficacy or increased risk of toxicity. Although virtually all of our knowledge of drug interactions is from data in humans, many of these interactions are also likely to occur in veterinary patients. The top ten potential offenders for drug interactions in the veterinary patients include:

1. Cimetidine

Cimetidine is a major P450 enzyme inhibitor, and decreases the breakdown of many drugs:

- Chloramphenicol: potentially leading to dose-dependent leukopenia
- Metronidazole: cimetidine may increase risk of cerebellar-vestibular side effects of metronidazole
- Lidocaine, procainamide, and quinidine: in humans, cimetidine also reduces the renal tubular secretion of procainamide.
- Theophylline and aminophylline
- Diazepam, midazolam
- Warfarin, propranolol, and many others....

Other H2 blockers such as ranitidine, and especially famotidine, are not P450 inhibitors at therapeutic concentrations, and should be chosen over cimetidine for patients that are being treated with multiple drugs.

2. Sucralfate

Aluminum-containing antacids (including sucralfate) can form complexes with many other drugs in the GI tract, markedly decreasing drug absorption:

- Fluoroquinolones: poor bioavailability even 6 hours after sucralfate in humans
- Tetracyclines: sucralfate inhibits tetracycline systemic absorbance, but interestingly, can help "deliver" tetracycline to Helicobacter-induced gastric ulcers
- H2 blockers: sucralfate delays, but does not decrease the extent of, the absorption of H2 blockers; therefore staggering of dosing is probably NOT required
- Theophylline, aminophylline: sucralfate may decrease efficacy
- Digoxin: sucralfate may decrease efficacy
- Azithromycin: sucralfate may decrease efficacy

3. Phenobarbital

Phenobarbital is a major P450 enzyme inducer. Phenobarbital speeds the metabolism of many drugs, including:

- Mitotane: higher loading and maintenance doses may be necessary
- Dexamethasone: but does not affect LDDST results
- Phenytoin: speeds the clearance of phenobarbital with little additional anticonvulsant activity
- Ketoconazole: phenobarbital may decrease efficacy
- Clomipramine: phenobarbital may decrease efficacy
- Chloramphenicol, griseofulvin, lidocaine, etodolac, theophylline, phenylbutazone, digoxin, propranolol, and many others...

4. Ketoconazole

For some drugs, such as ketoconazole and iron supplements, absorption is best at a very acidic pH; therefore, do not combine these drugs with:

- Omeprazole, H2 blockers, or antacids: increase in gastric pH impairs absorption of ketoconazole

Ketoconazole is also a major P450 inhibitor, and can decrease the clearance of many drugs:

- Cyclosporine: a favorable interaction when treating perianal fistulas in large dogs. Recommended dosages: cyclosporine, 4-5 mg/kg/day; ketoconazole, 10 mg/kg/day. Monitor ALT and clinical response. Whole blood cyclosporine can be measured at steady state (about one week). Aim for 500 ng/ml until in remission; lower concentrations of about 200 ng/ml will likely maintain remission.
- Digoxin: ketoconazole can lead to digoxin toxicity
- Clomipramine, amitriptyline, midazolam: ketoconazole may increase sedation
- Warfarin: ketoconazole may prolong its toxicity in rodenticide ingestions
- Some antihistamines: ketoconazole can lead to cardiotoxicity of astemizole (Hismanal), but not fexofenadine (Allegra), in humans

Note: Itraconazole, like ketoconazole, can also inhibit the P450 metabolism of the same drugs

5. Digoxin

Commercial antidiarrheals can adsorb and decrease the availability of digoxin:

- Kaopectate^{R} and Pepto-Bismol^{R}

Other drugs that can increase the risk of digoxin toxicity:

- Erythromycin: mechanisms include inhibiting P450 metabolism of digoxin in the enterocyte and inhibiting P-glycoprotein efflux of digoxin
- DSS: increases digoxin solubilization and absorption
- Furosemide: dehydration leading to decreased renal clearance of digoxin; hypokalemia leading to increased digoxin binding to target site
- Omeprazole: may inhibit digoxin clearance

6. Fluoroquinolones

Drugs containing calcium, aluminum, or iron can bind to, and markedly decease the absorption of, fluoroquinolones:

- Sucralfate, aluminum hydroxide, aluminum carbonate
- Calcium carbonate
- Oral iron supplements

In humans, fluoroquinolones inhibit the P450 metabolism of some drugs, and can lead to their toxicity:

- Theophylline, aminophylline: Fluoroquinolones inhibit theophylline breakdown via P450 inhibition. This can lead to theophylline toxicity in humans. Conservative theophylline dosages should be considered for patients treated with fluoroquinolones, e.g. for pneumonia. In cats or small dogs, terbutaline can be used instead for bronchodilation.

7. Metoclopramide

As a dopaminergic (D2) antagonist and prokinetic agent, metoclopramide has several important drug interactions:

- Enhanced absorption of acetaminophen, aspirin, and alcohol overdoses via increased gastric emptying in humans.
- Enhanced extrapyramidal side effects (tremor) in combination with phenothiazines or selective serotonin reuptake inhibitors (e.g. fluoxetine/Prozac)
- Metoclopramide (0.15 mg/kg IV single dose) reduces the amount of propofol needed for anesthetic induction in humans by 20-25% (mechanism unknown)

Although it has been suggested that metoclopramide may antagonize the effects of dopamine on renal hemodynamics, this may not be true:

- Oral or IV metoclopramide has no effect on low dose dopamine-induced increases in GFR or effective renal plasma flow in healthy humans
- Metoclopramide is a D2 receptor antagonist, and while D2 receptors are present in the kidney, much of the dopamine-mediated hemodynamic changes in the kidney are mediated via D1 receptors

8. Furosemide

Several drug combinations with furosemide can lead to enhanced toxicity:

- Amikacin and gentamicin: nephrotoxicity is enhanced by furosemide; therefore mannitol may be preferable to furosemide for the treatment of acute renal failure due to aminoglycosides.
- Enalapril and other ACE inhibitors: may cause acute renal failure (due to hemodynamic changes) when given with full doses of furosemide. Therefore, use conservative initial doses of furosemide (low end of dose range) when starting ACE inhibitors.
- Digoxin: furosemide increases serum digoxin levels (independent of dehydration) in both dogs and cats. Furosemide can also lead to hypokalemia and hypomagnesemia, both of which exacerbate the cardiac toxicity of digoxin. In addition, furosemide can lead to pre-renal azotemia, leading to decreased digoxin excretion. All of these interactions mandate that digoxin levels be monitored in patients treated with digoxin and other cardiac drugs, and that renal function and serum electrolytes be routinely evaluated during cardiac rechecks.

Other drug combinations with furosemide can affect efficacy:

- Lidocaine: hypokalemia secondary to furosemide can blunt the antiarrhythmic effects of lidocaine. Serum potassium should be evaluated in patients with ventricular arrhythmias, and potassium supplementation should be instituted if patients do not respond initially to lidocaine.
- Bromide: furosemide administration will increase the renal loss of bromide, and lower serum bromide concentrations, which may lead to seizure breakthrough

9. Clomipramine

As a tricyclic antidepressant that inhibits norepinephrine reuptake, clomipramine can have pharmacologic interactions with MAO inhibitors (which decrease the breakdown of norepinephrine and serotonin)

- L-deprenyl (selegiline): MAO inhibitors like L-deprenyl used in combination with tricyclic antidepressants like clomipramine or amitriptyline can lead to "serotonin syndrome" (twitching, tremor, seizures) in humans
- Amitraz: an MAO inhibitor found in tick dips and collars; potential for interaction with tricyclic antidepressants like clomipramine

Clomipramine is also highly protein bound, and is displaced from albumin by:

- Phenytoin
- NSAID's (aspirin, phenylbutazone, others?)

The metabolism of clomipramine can be inhibited by:

- Fluoxetine (Prozac): can lead to increased clomipramine levels and cardiac conduction disturbances in humans
- Ketoconazole, itraconazole

10. Omeprazole

Omeprazole is a P450 inhibitor, and may inhibit the metabolism, and possibly increase the toxicity, of a number of drugs:

- Diazepam
- Phenytoin
- Warfarin
- Digoxin
- Carbamazepine

As an inhibitor of gastric acid secretion, omeprazole can also decrease the absorption of:

- Iron supplements
- Ketoconazole and itraconazole (but not fluconazole)

Drug	May increase the toxicity of:	May decrease the efficacy of:	Toxicity may be increased by:	Efficacy may be decreased by:
Cimetidine	Chloramphenicol, metronidazole, lidocaine, procainamide, quinidine, theophylline and aminophylline, warfarin, diazepam, midazolam, propranolol...	Ketoconazole, itraconazole, iron supplements		
Sucralfate		Fluoroquinolones, penicillins, tetracycline, doxycycline, erythromycin, theophylline, digoxin		
Phenobarbital	Acetaminophen	Mitotane, digoxin, dexamethasone, phenytoin, doxycycline, chloramphenicol, griseofulvin, lidocaine, quinidine, theophylline, phenylbutazone, propranolol, clomipramine...	Phenytoin	Charcoal, phenylbutazone
Ketoconazole	Cyclosporine, warfarin, digoxin, clomipramine, amitriptyline, midazolam			Antacids, H_2 blockers, omeprazole, rifampin
Digoxin			Erythromycin, DSS, furosemide, omeprazole	Pepto-Bismol, kao-pectate, antacids, rifampin, phenobarbital
Fluoroquinolones	Theophylline			Sucralfate, iron, calcium, magnesium, aluminum-containing antacids
Metoclopramide	Ethanol, aspirin, or acetaminophen overdoses; propofol induction	Probably *does not* counteract the renal effects of IV dopamine	Aceprozamine, fluoxetine (tremor)	
Furosemide	ACE inhibitors, aminoglycosides, digoxin	Bromide, lidocaine (via hypokalemia),	Aminoglycosides	NSAID's
Clomipramine	Amitriptyline, amitraz, selegiline		Phenytoin, aspirin, phenylbutazone, fluoxetine, selegiline, ketoconazole	Phenobarbital
Omeprazole	Diazepam, phenytoin, warfarin, digoxin, carbamazepine	Ketoconazole, itraconazole, iron supplements		

Transdermal Drugs: What Do We Know?

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I. Transdermal formulations
  A. Emulsifying agents
    1. PLO (Pluronic lecithin organogel)
      a) Pluronic F127
        (1) Polymeric surfactant
        (2) Enhances drug micelle formation
          (a) Shown to enhance the skin permeation of some drugs *in vitro* and *in vivo*.
      b) Lecithin
        (1) Increases fluidity of stratum corneum
        (2) Leads to exfoliation of stratum corneum and low grade inflammation with chronic use
      c) PLO separates at cold temperatures
        (1) Do not refrigerate
        (2) Do not send through mail during cold months
    2. Lipoderm
      a) Proprietary formula containing lecithin
      b) Less greasy than PLO
      c) Can be refrigerated
    3. VanPen
      a) Proprietary formula used for more lipophilic drugs
  B. Organic solvents
    1. Glycol ether/isopropanol
      a) Used in Revolution for transdermal absorption of selamectin
    2. Propylene glycol
    3. Ethanol
    4. DMSO
      a) Not recommended
        (1) Local irritation
        (2) Odor
        (3) Inadvertent absorption of skin contaminants
  C. Patches
    1. Rely on high local concentrations of drug in matrix such as acrylic
    2. Older patches had drug in alcohol or other solvent, which led to skin irritation

II. Absorption and efficacy of transdermal veterinary drugs

A. Nitroglycerin ointment
   1. Effective venodilator to reduce preload in acute heart failure
   2. Absorbed transdermally
      a) Small molecule
      b) Local venodilation, increased blood flow

B. Fentanyl patch
   1. Well established method of post-operative pain relief in dogs and cats
      a) Spay, declawing, orthopedic procedures
      b) Less sedation or hypothermia compared to injectable narcotics
   2. 25, 50, 75, 100 ug/hr sized patches
   3. Applied to shaved skin that is cleaned with warm water and alcohol, and *dried thoroughly* before application
   4. Dose: 3-5 ug/kg/hr
      a) For cats smaller than 4 kg, consider exposure of only half of a 25 ug/hr patch (Do not cut patch!) (Davidson, J Am Vet Med Assoc, 2004)
   5. Drawbacks of fentanyl patch:
      a) Variable absorption
      b) Must be applied prior to need for analgesia
         (1) Cats:
            (a) Apply 12 hours prior to surgery
            (b) Analgesic concentrations sustained for 3-5 days
         (2) Dogs
            (a) Apply 18-24 hours prior to surgery
            (b) Analgesic concentrations sustained for 1-3 days
      c) Hypothermia decreases absorbed fentanyl concentrations (e.g. under anesthesia)

C. Methimazole
   1. Poor absorption after a single dose, but...
   2. Effective in lowering serum T4 with chronic administration in hyperthyroid cats
      a) Methimazole in PLO, no DMSO; 50 mg/ml (5 mg per 0.1 cc)
      b) 2.5 mg q. 12 h. to inner pinna
      c) Owners wear exam gloves or finger cots
      d) Alternate ears with each dose
      e) Remove crusted material before next dose
   3. Fewer GI side effects (4% of cats) compared to oral (24%) methimazole (Sartor et al., *J Vet Intern Med*, in press)
   4. No difference in incidence of facial excoriation, neutropenia,, thrombocytopenia, or hepatotoxicity
   5. Somewhat lower efficacy (67% euthyroid by 4 weeks) compared to oral methimazole (82% euthyroid by 4 weeks)
   6. Drawbacks of methimazole in PLO
      a) Erythema at dosing site in some cats
      b) Increased cost due to formulation
      c) Stability guaranteed for only 2 weeks

D. Fluoxetine
   1. Fluoxetine (15% in PLO, = 150 mg/ml) is only 10% bioavailable relative to oral fluoxetine (Ciribasssi, *Am J Vet Res*, 2003)
   2. Roughly comparable AUC values for fluoxetine and its active metabolite, norfluoxetine, can be obtained by dosing transdermal fluoxetine at 10 mg/kg (compared to the 1 mg/kg oral dose)
   3. Slower absorption and lower peak serum concentrations with the transdermal route
   4. Skin irritation with repeated doses

E. Fentanyl and morphine in PLO

1. Essentially undetectable (below limit of quantitation) serum levels after single transdermal doses of 0.88 mg/kg of transdermal fentanyl (almost 90 times the IV dose) and 2 mg/kg of transdermal morphine (almost 7 times the IV dose) (Krotscheck, ACVIM Proceedings, 2003)

F. Dexamethasone
1. No significant absorption after single transdermal dose in PLO (0.05 mg/kg) (Willis-Goulet, xx, 2003)
2. Multiple dose studies needed

G. Buspirone, amitriptyline in cats
1. Poor transdermal absorption after single transdermal doses (Mealey, J Vet Intern Med, 2004)
2. Multiple dose studies needed

H. Diltiazem
1. Poor transdermal absorption after a single dose of 7.5 mg per cat (DeFrancesco, ACVIM Proceedings, 2003)
2. Bioavailability 10% that of IV diltiazem
3. Multiple dose studies needed

I. EMLA
1. Euctectic mixture of local anesthetics (lidocaine and prilocaine)
2. Effective in our hands for topical/local analgesia in cats
3. Essentially no transdermal (systemic) absorption of lidocaine or prilocaine (and no side effects) in healthy or sick cats when dosed at 1 gram of cream over 10 cm^2 area, with one hour of occlusion (Gibbon, *J Vet Pharm Ther*, 2003; Wagner, 2004, in preparation)
4. Earlier study also showed safety (minimal systemic transdermal absorption) of a 4% liposome-encapsulated lidocaine formulation applied at 15 mg/kg over the cephalic vein in cats, without occlusion (Fransson 2002)

III. Dosing of transdermal drugs without absorption or efficacy data

A. Only relatively potent drugs are developed for transdermal use in humans
1. Total daily dosages less than 50 mg per day (for 70 kg. person)
   a) Existing patches limited in size to 50 cm^2 (less than 3 inches square)
   b) Stratum corneum barrier limits transdermal delivery to about 1 mg per cm^2 of skin surface area

B. *There is no single useful rule* to extrapolate an oral dose to a transdermal dose
1. Transdermal dose needed may be much higher (if skin penetration is poor)
2. Transdermal dose may be the same (if transdermal and oral absorption are comparable)
3. Transdermal dose may be much lower (if oral drug is subject to a lot of first pass hepatic metabolism)

C. Choose only drugs with a quantitative therapeutic endpoint
1. Start with a low dose, and titrate to therapeutic effect

D. The transdermal route is *not recommended for empirical dosing of antimicrobials*
1. Dosage usually exceeds 50 mg rule
2. Dose titration to therapeutic effect could lead to microbial resistance

E. The transdermal route is *not recommended for empirical dosing of drugs for conditions that require immediate efficacy*
1. Significant hypertension
2. Bronchospasm
3. Seizures
4. Arrhythmias
5. Heart failure

Checklist for the use of transdermal medications without absorption or efficacy data

- Is there a quantitative endpoint that can be measured?
  - T4
  - Heart rate
  - Blood pressure
  - Blood glucose
  - Plasma drug levels
- Does the drug have a relatively large therapeutic window?
- Are proven routes (oral or parenteral) *not possible* in this patient?
- Have you informed the client that the appropriate dosage is not established for this route, and that other, better established routes are available?
- Will your pharmacy tell you what is in the formulation?
- Can your pharmacy provide you with a shelf life for the formulation?
- Do you have a rationale for your dose?

Recent quote from a custom compounding pharmacy web site:

"Transdermal gels offer many advantages: due to the excellent absorption of the drug, smaller amounts of drug can be given, which can greatly reduce the side effects your pet may experience." **Is this true?**

Drug Dosage Adjustment for Disease

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I. Changes in drug disposition due to age and body composition
- A. Neonate
  1. Immature renal tubular function prior to 8 weeks of age
     a) Avoid digoxin, aminoglycosides, ACE inhibitors, NSAID's
  2. Physiologic hypoalbuminemia
     a) Caution in dosing highly protein bound drugs such as diazepam or NSAID's
  3. Decreased body fat
     a) Use lower doses of lipid soluble drugs such as anesthetics
  4. Increased target organ susceptibility
     a) Cartilage damage from enrofloxacin in puppies, but not significant in kittens
     b) Increased anesthetic effects due to immature blood brain barrier at < 8 weeks of age
     c) Predisposition to hypotension due to poor cardiac compliance and immature baroreceptors
- B. Geriatric
  1. Decreased renal function due to nephron loss
     a) Increased risk of aminoglycoside, digoxin, ACE inhibitor toxicity
     b) Use lower doses of renally cleared drugs
  2. Decreased muscle mass
     a) May see increased serum digoxin concentrations, and increased toxicity, in cachectic old dogs and cats (digoxin distributes to skeletal muscle)
  3. Decreased total body water
     a) May see erratic SC absorption in older patients
     b) Consider IM or IV routes in geriatrics
  4. Decreased liver blood flow (seen in older humans)
     a) Use lower doses of "flow-limited" drugs such as propranolol and hydralazine
- C. Obesity
  1. Use dosing based on lean body weight (ideal body weight) for polar, water-soluble drugs with poor fat distribution, such as:
     a) Gentamicin
     b) Digoxin
  2. Lean body weight can be estimated from breed standards, or previous medical records for individual patients.
     a) Alternatively, an empirical dose reduction by 15-20% can be estimated for obese patients given these drugs

II. Changes in drug disposition due to disease
- A. Heart failure
  1. Decreased cardiac output
     a) Leads to preferential shunting of blood to brain and heart
     b) May enhance cardiac toxicity (arrhythmias) and CNS toxicity (nausea) from digoxin
  2. Prerenal azotemia
     a) Requires lower doses of enalapril, digoxin, furosemide
  3. Gastrointestinal edema
     a) May lead to erratic oral absorption of some drugs during acute heart failure
  4. Many potential drug interactions

a) Furosemide and digoxin
b) Furosemide and enalapril
c) Enalapril and spironolactone
d) Digoxin and propranolol
e) Digoxin and diltiazem
f) Lidocaine and digoxin

B. Hepatic insufficiency
1. Decreased metabolism of some drugs
a) In humans with cirrhosis, some drugs that are normally extensively metabolized are not cleared as readily
b) Based on human data, dosages of the following drugs should probably be reduced in dogs and cats with severe liver disease:
(1) Propranolol (decrease dose by 50% or more)
(2) Chloramphenicol (use 25% of regular dose, or better, choose another drug)
(3) Metronidazole (use 25-50% of regular dose)
(a) Substitute lactulose or neomycin (for encephalopathy)
(b) Substitute amoxicillin/clavulanate (for systemic anaerobic therapy)
(4) Diazepam or midazolam (use 25-50% of regular dose and use sparingly if treating encephalopathic seizures)
2. Hypoalbuminemia
a) Increased acute effects from highly protein drugs such as aspirin and benzodiazepines
3. Ascites
a) Use the total body weight (including ascites fluid) to calculate dosage of aminoglycosides or other polar drugs
b) Use the normal body weight (minus estimated ascites fluid weight) to calculate dosage of lipid soluble drugs such as anesthetics and vitamin K_1
4. Increased sensitivity to CNS depressants
a) Opioids: reduce dose or use reversible agents
b) Benzodiazepines, acepromazine: avoid or use reduced dosages
c) Barbiturates: avoid or use reduced dosages
(1) For encephalopathic seizures, use phenobarbital at 20-30% of standard doses and titrate upwards
5. Hepatic encephalopathy
a) Avoid stored whole blood and packed red blood cell transfusions (high ammonia levels)
b) Avoid NSAID's
(1) Risk of GI bleeding
c) Avoid furosemide
(1) Hypokalemia, dehydration, azotemia, alkalosis all exacerbate encephalopathy
(2) Consider spironolactone / hydrochlorthiazide instead (1 mg/kg BID)
d) Avoid 0.9% saline IV
(1) Often leads to edema, worsens ascites
(2) Consider 1/2 strength saline with 2.5% dextrose, and added potassium, for liver patients
e) Avoid glucocorticoids
(1) Catabolic; enhance deamination of proteins and release of NH_3
f) Consider lactulose and neomycin over metronidazole
(1) Less likely to cause neurologic signs
g) If benzodiazepines lead to respiratory depression, consider reversal with flumazenil
(1) Benzodiazepine antagonist
(2) Dose *in humans (70 kg)*: 2 mg bolus; 1 mg per hour CRI

(3) Side effects in humans: vomiting, vertigo, vasodilation, ataxia

(4) May cause seizures in patients with a history of chronic benzodiazepine administration

C. Renal failure

1. Renal failure leads to:
   a) Decreased filtration of renally eliminated drugs and active metabolites
   b) Decreased tubular secretion of some drugs
      (1) Digoxin, cimetidine, trimethoprim, quinidine
   c) Decreased *renal* P450 and conjugative metabolism of some drugs
   d) Decreased binding of acidic drugs to albumin
      (1) Furosemide, sulfamethoxazole, aspirin
   e) Reduced tissue binding of some drugs
      (1) Digoxin
2. Once isosthenuria appears (GFR is less than 30-40% of normal; 2/3 of functional nephrons are lost), doses of renally excreted drugs should be adjusted
3. For many drugs, a crude dose reduction can be made by adjusting the amount given based on the serum creatinine
   a) Divide the dose by the serum creatinine in mg/dl (i.e. less drug given at same intervals)
   b) Roughly accurate for serum creatinine concentrations less than or equal to 4 mg/dl
   c) Exception is aminoglycosides (and probably fluoroquinolones), for which the dose interval should be extended instead (see below)
4. Drugs that require dose reductions in renal failure:
   a) Penicillins
      (1) Toxicity unlikely, but dose reduction is appropriate and will also decrease the cost of using more expensive penicillins (such as ticarcillin) in patients with azotemia
   b) Cephalosporins
      (1) Cephalothin and cefazolin can be nephrotoxic at very high doses in humans, so dose reduction of these two drugs in renal failure is important
      (2) Cephalothin and cefazolin can also be nephrotoxic in combination with gentamicin to elderly humans; avoid this combination in older dogs and cats
   c) Aminoglycosides
      (1) Use other agents whenever possible (enrofloxacin, ticarcillin, cefotetan)
      (2) When necessary for use in patients with pre-existing renal failure:
         (a) Always rehydrate first
         (b) Always use concurrent fluid therapy (preferably IV)
         (c) Consider less nephrotoxic forms of aminoglycosides
            (i) Amikacin 15 mg/kg SC q. 24h
            (ii) Netilmicin 6-8 mg/kg SC q. 24h
         (d) Monitor for tubular damage by examining daily fresh urine sediments for granular casts
         (e) Reduce the dose by multiplying the dose interval by the serum creatinine
            (i) e.g. For a serum creatinine of 2 mg/dl, dose every 48 hours instead of every 24 hours
         (f) Do not use aminoglycosides in patients with urinary obstruction
         (g) Do not use furosemide or NSAID's concurrently
         (h) Limit aminoglycoside therapy to 5 days or less whenever possible

d) Tetracyclines
   (1) Use doxycycline instead for patients with renal insufficiency
   (2) Tetracyclines can increase BUN, independent of any renal damage, due to protein catabolism (increase is reversible)
   (3) Never use outdated tetracyclines (breakdown products are nephrotoxic)

e) Chloramphenicol
   (1) In cats, 25% or more is excreted unchanged in the urine; therefore, avoid use in cats with renal insufficiency or reduce the dose

f) Sulfonamides
   (1) Decreased renal clearance and decreased protein binding
   (2) Reduce dose in renal failure (especially sulfadiazine, which can form drug crystals in the renal tubules and lead to hematuria)
   (3) Rehydrate first
   (4) Dose accurately
   (5) Avoid use with methotrexate (combination can precipitate in urine and cause tubular damage)
   (6) Avoid urinary acidifiers

g) Digoxin
   (1) Reduce dose in renal failure
   (2) Decreased renal filtration, tubular secretion, and skeletal muscle binding leads to increased serum concentrations in uremia

h) Furosemide
   (1) Dehydration, hypokalemia, acute renal failure
   (2) Use conservative dosages and monitor carefully

i) Cimetidine / ranitidine / famotidine
   (1) CNS disturbances reported in elderly humans with decreased GFR when given cimetidine without appropriate dose reductions
   (2) Reduce dose in renal failure

j) Metoclopramide
   (1) Standard CRI dosages (1-2 mg/kg/day) may cause tremor and ataxia in azotemic patients

k) ACE inhibitors
   (1) Decreased renal clearance (enalapril, but not benazepril), and adverse effects on GFR
   (2) Monitor BUN, creatinine, and electrolytes in patients with azotemia

l) NSAID's
   (1) Decreased renal clearance, decreased protein binding, and adverse effects on GFR
   (2) Use conservative NSAID dosages with azotemia, and monitor carefully
   (3) Coxibs *not* safer in renal insufficiency

D. Hypokalemia

1. Caution with drugs that induce or worsen hypokalemia, such as:
   a) Furosemide
   b) Prednisone
   c) Insulin
   d) Sodium bicarbonate
   e) Unsupplemented saline
   f) IV dextrose
   g) Terbutaline

(Specific references can be provided upon request)

Treating Resistant Bacterial Infections

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General therapeutic principles to avoid resistance

- Culture and sensitivity, ideally initially, but *certainly after a first failure.*
- Start with an effective dose, ideally based on pharmacokinetics done in dogs and cats.
- Don't compromise on frequency, especially for beta-lactams.
- Educate clients to complete the entire course of treatment.
- Reculture after therapy to confirm resolution of infection in chronic cases.

Finding an antimicrobial for a resistant infection

- Culture and sensitivity!
- Request MIC's (minimum inhibitory concentrations) with your sensitivity results.
- Ask for additional antimicrobial sensitivities if necessary.
- Evaluate the available antimicrobial options for efficacy, potential side effects, cost, and convenience.

Potentiated Penicillins

- Beta-lactams (pencillins and cephalosporins) exhibit "time-dependent" killing: bacterial kill is greatest with continual exposure to drug concentrations above the MIC, but increasing the dose any further does not increase efficacy.
- Because of this, it is important that beta-lactam antibiotics be given at recommended intervals, especially for gram-negative infections.
- Reducing the frequency of administration for convenience, even if the dose is increased, may lead to therapeutic failure.

Ticarcillin or Ticarcillin plus clavulanate potassium (Ticar or Timentin).

- Extended gram negative spectrum, while retaining some gram positive and anaerobic coverage.
- Useful for cultured, resistant *Pseudomonas, Enterococcus*, and *Haemophilus.*
- Based on the MIC_{90} for *Pseudomonas* isolates from dogs and cats at the UW VMTH, our estimated dose for ticarcillin alone is 15-25 mg/kg as an IV infusion over 15 minutes, followed by a CRI at 7.5 - 15 mg/kg/hr. (Intermittent dosages would require dosing every 2-3 hours and are not practical).
- Ticarcillin has been used successfully for *Pseudomonas* otitis media in dogs associated with ruptured tympanic membranes when given both parenterally and topically in the ear canal.
- Ticarcillin and other beta-lactams are synergistic with aminoglycosides.
- A number of beta lactam antibiotics can inhibit platelet function, but clinical bleeding should be uncommon at therapeutic dosages. In one study in dogs, buccal mucosal bleeding times were prolonged only when doses of 750 mg/kg/day or more of ticarcillin were give.

Extended spectrum cephalosporins

Cefoxitin (Mefoxin)

- Cefoxitin is a second generation cephalosporin with a good broad spectrum including anaerobes.
- Useful as a single agent for serious mixed infections (e.g. aspiration pneumonia, bowel perforation).
- Dose in dogs: 30 mg/kg SQ q. 8h; 30 mg/kg IV q. 4-6 h.

Cefotetan (Cefotan)

- Cefotetan is another second generation cephalosporin that also has a good broad spectrum including anaerobes.

- Has more favorable kinetics than cefoxitin in dogs, and can therefore be given less frequently.
- Also has slightly better spectrum against *E. coli* than cefoxitin.
- Dose in dogs: 30 mg/kg SQ q. 12 h; 30 mg/kg IV q. 8 h.

Ceftriaxone (Rocephin)

- A third generation cephalosporin which reaches high CSF concentrations, especially in dogs with inflamed meninges (>20X plasma concentrations).
- Excellent drug for bacterial meningitis.
- Used for Lyme meningitis in humans.
- Empirical dose in dogs: 15-50 mg/kg q. 24 h.

Ceftazidime (Fortum, Kefadim)

- A third generation cephalosporin that is the drug of choice for cultured, resistant *Pseudomonas*.
- Unfortunately, it requires a continuous rate infusion in dogs due to short half-life.
- The calculated dose in dogs is 4.4 mg/kg loading dose, followed by 4.0 mg/kg/hour. This dose surpasses the MIC for most canine *Pseudomonas* isolates.

Other Beta-Lactams

Monobactams (e.g. aztreonam) and carbapenems (e.g. imipenem) both contain modified beta-lactam rings, and have a similar mechanisms of action to penicillins and cephalosporins. They are bactericidal, but are resistant to beta-lactamases. These antibiotics are expensive and should be reserved for cultured, highly resistant infections.

Aztreonam (Azactam)

- Aztreonam is effective against gram negative aerobes and can be used as a non-nephrotoxic (albeit expensive) alternative to aminoglycosides.
- Aztreonam may be useful for *Pseudomonas* infections that are resistant to aminoglycosides or that are found in patients with preexisting renal disease.
- Excreted mainly by the kidneys, aztreonam is non-nephrotoxic and non-ototoxic.
- Empirical dose in dogs (based on human dose and shorter half-life seen in dogs): 30 mg/kg IV q. 6h.
- Decrease the dose if the serum creatinine is elevated.

Imipenem

- Imipenem is a uniquely broad spectrum beta-lactam derivative (a carbapenem) with efficacy against gram positive and gram negative aerobes and anaerobes.
- Good spectrum against *Pseudomonas*.
- Available in combination with cilastatin as Primaxin (cilastatin prevents renal degradation of imipenem and increases urinary concentrations without nephrotoxicity).
- Two forms are available, one for IV injection only, and one for IM use only (routes and formulations are not interchangeable).
- Empirical dose in dogs and cats is 5-10 mg/kg q. 6 hours. When given IV, should be given as an IV infusion over 30 minutes, diluted in 100 mls of saline. Can also be given SQ as diluted for IV administration.
- For IM injection only, imipenem can be reconstituted in 1% lidocaine to reduce pain.
- May be useful for broad spectrum of documented bacteremia, mixed infections (e.g. bowel contamination, aspiration pneumonia), or febrile neutropenic patients with cultured, resistant organisms.
- Caution: imipenem may lower the seizure threshold in epileptics or patients with CNS infections.

Meropenem

- Meropenem is similar to imipenem but is more soluble and has less CNS toxicity.
- Recommended dosage based on pharmacokinetics in dogs is 8 mg/kg SQ q. 12 hours (for organisms with an MIC < 0.12 ug/ml). (Bidgood & Papich, Am J Vet Res, 2002)

Aminoglycosides

- Aminoglycosides provide excellent coverage of many resistant gram negative infections, with the risk of dose-dependent nephrotoxicity and ototoxicity.
- Aminoglycosides have no anaerobic spectrum, limited gram positive spectrum, and poor CNS and ocular penetration, even with inflammation.
- Aminoglycosides have poor activity in abscesses (acid pH) or in areas of tissue necrosis (free calcium inhibits aminoglycoside activity).
- All aminoglycosides should probably be given on a once a day schedule. This is more convenient, may be more efficacious, and is less toxic in some animal models.
- Aminoglycosides exhibit *concentration-dependent killing*, such that higher peak serum concentrations (obtained with q. 24h dosing) are associated with greater bacterial kill.
- Finally, once daily dosing is associated with less toxicity because lower urinary concentrations at the end of the dosing interval means less uptake into renal tubular cells.
- One possible exception to the recommendation of once daily dosing for aminoglycosides is in the treatment of neutropenic or other immunocompromised patients, for which aminoglycosides which may still need to be given in divided doses q. 8h.

Gentamicin

- (Genticin; 6-8 mg/kg q. 24h) is surprisingly still the aminoglycoside of choice for many human patients, despite its nephrotoxic potential (it is even used in renal transplant patients and in neonates).

Amikacin

- (Amikin; 15 mg/kg q. 24h) is less nephrotoxic than gentamicin in humans, dogs, and cats, and has a slightly broader spectrum against resistant gram negative aerobes.
- Amikacin is preferred over gentamicin for use with carbenicillin, due to greater drug stability in combination.

Fluoroquinolones

- Fluoroquinolones exhibit excellent broad spectrum coverage except against most anaerobes. They are also effective against intracellular organisms (*Mycoplasma, Chlamydia*).
- All fluoroquinolones reach good CSF concentrations (e.g. equivalent to serum concentrations and 10X the MIC for *E. coli* after a 5 mg/kg dosage of enrofloxacin).
- Excellent concentrations in the lower respiratory tract (10X plasma concentrations for enrofloxacin). This feature extends this drug's efficacy against some resistant respiratory pathogens.
- Like aminoglycosides, fluoroquinolones exhibit concentration-dependent bacterial killing and a post-antibiotic effect for many bacteria. They are concentrated in the urine, so lower dose ranges can be used for UTI's.
- Avoid co-administration of fluoroquinolones with sucralfate, magnesium and aluminum-containing antacids, and calcium and iron supplements, which markedly decrease the oral absorption of all fluoroquinolones.
- Bacterial resistance to fluoroquinolones is not mediated by plasmids but *can* occur through mutations in bacterial chromosomes, leading to stable transmission to offspring bacteria and efficient cross-resistance to other fluoroquinolones. Use these drugs judiciously!

Enrofloxacin

- Baytril; 5mg/kg once daily
- Enrofloxacin alone is a good choice for resistant bronchopneumonias (including *Mycoplasma* and *Chlamydia*), chronic prostatitis (good prostate concentrations and effective against gram negatives including *Brucella*), some *Pseudomonas* infections (otitis, cystitis, pyelonephritis), and deep pyodermas.
- Enrofloxacin can be diluted 1:5 in sterile saline and given as *slow* IV infusion over 20-30 mins.
- Enrofloxacin and amoxycillin/clavulanate in combination provide excellent oral follow-up therapy of serious infections (pneumonias, endocarditis, resistant pyelonephritis).
- Enrofloxacin (22.7 mg/ml injectable) has been used topically for otitis externa. Diluted 1:4 in saline, it is stable for 2 weeks (Papich, 1998).
- Even higher dilutions (1:100, or 227 ug/ml) should still be efficacious topically for most organisms.

Ciprofloxacin

- Ciprofloxacin has increased activity towards *Pseudomonas* compared to enrofloxacin, but it is not as well absorbed (enrofloxacin, approximately 50% bioavailability; ciprofloxacin, approximately 10% bioavailability in dogs).
- After oral dosing in dogs (10-20 mg/kg once daily) ciprofloxacin reaches peak plasma concentrations of 1.5 to 3 ug/ml, which is only *at* the MIC for some resistant organisms. And after oral administration of enrofloxacin (5 mg/kg), even lower concentrations of ciprofloxacin are achieved (0.2-0.3 ug/ml).
- For organisms with an MIC of 1-2 ug/ml, ciprofloxacin can be given intravenously in dogs at 5-20 mg/kg IV to achieve therapeutic concentrations Seizures may result from high doses of enrofloxacin or ciprofloxacin given IV, so use caution and infuse the drug slowly over 30 minutes.
- Very resistant organisms (MIC greater than approximately 2-4 ug/ml) would need to be treated with a different antibiotic, although resistant infections in the urinary tract or lungs may still be responsive due to drug concentrations higher than plasma at these sites.

Marbofloxacin (Zenequin)

- Clinically similar to enrofloxacin with regard to efficacy and post antibiotic effect.
- May have a more favorable Cmax: MIC_{90} ratio for Pseudomonas sp. than either enrofloxacin or orbifloxacin.
- No retinal degeneration in cats experimentally at relevant dosages.

Macrolide derivatives

Azithromycin

- Derived from erythromycin, but better oral absorption, longer half-life (especially in tissues), higher tissue and leukocyte concentrations, and broader spectrum of activity.
- Spectrum closely resembles that of clindamycin.
- Effective against gram positive cocci, anaerobes, and intracellular organisms.
- Empirical dose in dogs and cats: 5-10 mg/kg orally once daily.
- Optimal duration of therapy not established
- Was effective in treating clinical signs, but did not completely clear infection, in cats chronically infected with Chlamydia (Owen, J Feline Med Surg, 2003)
- Maintains tissue drug concentrations in cats greater than 1 ug/ml for 24 hours in most tissues, despite falling plasma concentrations

Peptide antibiotics

Vancomycin

- Glycopeptide antibiotic that inhibits cell wall synthesis (different site than for beta-lactams).
- Excellent spectrum against gram positive cocci (both aerobic and anaerobic), but no activity against gram negatives.
- Must be given IV due to poor oral absorption.
- Recommended dose in dogs (based on canine kinetics): 10 mg/kg IV q. 6 hours in dogs. Cannot be given IM. Infuse over 30 to 60 minutes, since too rapid administration can cause tachycardia and histamine release.
- Vancomycin is both ototoxic and nephrotoxic.
- To avoid toxicity, (based on recommendations in humans), do not exceed peak concentrations of 60 ug/ml, and keep trough concentrations below 5 ug/ml.
- Synergistic efficacy (and toxicity) with aminoglycosides.
- Vancomycin is excreted primarily by the kidneys, so use with caution in azotemia and reduce the dosage in renal failure.
- Used in humans for serious gram positive infections (e.g. *Staph* bacteremia, endocarditis), either in penicillin-allergic patients or when resistant strains are present.
- *Do not use this drug indiscriminately and never without a culture!* Vancomycin is often the only agent available for serious methicillin-resistant *Staph.* bacteremias in humans, and emerging resistance is a big threat.

Rifamycins

Rifampin

- Inhibits DNA-dependent RNA polymerase (prevents initiation of RNA synthesis).
- Good spectrum against gram positive cocci, *Clostridia*, and Mycobacteria.
- Should be used in combination regimens, since resistance develops quickly when rifampin is used alone.
- Potent inducer of the P450 metabolism of other drugs (*many* drug interactions).
- Suggested dose: 10-20 mg/kg PO q. 8-12 h. (extrapolated from human pediatric dose).
- Potential indications: combination therapy of atypical Mycobacterial infections; treatment of resistant *Staph.* endocarditis (in combination with amoxicillin/ clavulanate or trimethoprim-sulfa).

Metronidazole

Metronidazole

- Very good choice for cultured anaerobes such as Bacteroides, Fusobacterium, Clostridium, Peptostreptococcus, and Porphyromonas.
- Close to 100% efficacy against 197 cultured anaerobic veterinary strains in two surveys.
- Other good choices for anaerobes: Amoxicillin/ clavulanate (99-100% of strains sensitive); chloramphenicol (97-100% of strains sensitive), and clindamycin (83-92% of strains sensitive).
- Recommended anti-anaerobic dose of metronidazole: 15-30 mg/kg/day.

Considering Older Cats

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There are now more elderly pet cats than ever before. Cats are more popular than dogs as pets, and improvements in nutrition, health care and management have lead to many cats living to increasingly greater ages. In the United States of America, over the last 10 years, there has been a nearly two fold increase in the percentage of pet cats of over 6 years of age (from 24% to 47%)[1], a 15% increase in cats over 10 years of age[2], and the proportion of the feline population aged 15 years or older has increased from 5% to 14%[3]. While less data are available for cats in Europe, the average age has increased from 4.7 to 5.3 years[4] and it is estimated that there are currently ~2.5 million 'senior' cats in the UK. Since this accounts for ~30% of the pet cat population[5] the good management of these individuals is becoming an ever more important consideration for small animal veterinary practitioners and nutritionists.

In order to determine the best ways to care for our older cats we first need to decide at what age a cat become 'senior', and then at what age it becomes 'geriatric'. However, cats, like people, do not age consistently and chronological age does not always match physiological age. Some cats show obvious signs of old age after 10 years, while others appear almost unchanged until they reach 15-16 years. That said, it is generally considered that cats become 'senior' at about 7-8 years of age and progress to 'geriatric' by 12-15 years. Interestingly, some authors recommend that longer-lived breeds, such as Siamese, should be considered as 'senior' when they reach 11-12 years, while shorter-lived breeds, such as the Persian, may become 'senior' by 6-7 years. Table 1 shows the approximate correlation between cat and human ages.

It is only by understanding how cats change with age that we can try to care for them in ways that best support a long and healthy life. To do this we need to know how their advancing age is affecting their bodies. Some changes are obvious, like whitening of hair, general decline in body and coat condition, and failing senses (sight and hearing). However, other changes are less obvious, and these include alterations in the physiology of the digestive tract, immune system, kidneys, liver, brain, and skeleton. Thankfully, there are now an increasing number of studies investigating the effects of ageing in cats, so we no longer need to rely on extrapolation from other species.

All aspects of a cat's life may affect its potential longevity and overall quality of life. However, perhaps the most important concepts to understand involve the complex interplay between concurrent physiological and pathological changes and how these affect the older cat's ability to maintain its body weight, accommodate to changes in its environment, fight off infection, and cope with disease. A number of these interacting factors will be discussed below.

Changes in body weight:
Older animals often experience changes in their body weight. It is recommended that owners keep a regular record of their cat's weight and that this is checked at each clinic visit. This is because significant and/or rapid weight change can have very serious implications, irrespective of the underlying cause.

Until recently, it was assumed that older cats, like dogs and humans, have a significantly reduced energy requirement, and therefore a tendency to obesity. Indeed, a slight trend towards a decreased maintenance energy rate (MER) has been shown in cats of up to 10 years of age. However, there is also increasing evidence that there is a much greater tendency for geriatric cats (of over 10 years of age) to be underweight[6-9] (See Table 2). The difference in the risk of mid-life obesity between cats and dogs probably results from their differing lifestyles. Dogs tend to be energetic when young, then slow down as they age. In contrast, cats are relative inactive throughout most of their lives. It is probably because of this that they do not show a significant age-related decline in either MER or lean body mass to fat ratio[7,10,11].

Ideally, cats should be fed to maintain their optimal body weight, and probably the single most important aspect to feeding older cats is that their body weight should remain stable. Long-term studies have shown that either obesity or excessive thinness increases mortality[8]. While obesity itself reduces life

span, it also increases the risk of many weight-related diseases, including heart disease, diabetes mellitus (DM), lameness (often due to arthritis), liver disease (e.g. hepatic lipidosis), and skin problems[12].

Many older cats experience weight loss. This can result from a number of different, often interacting, factors. These may include physiological ageing changes, the presence of pathological disease processes, or behavioural alterations. Weight loss is often associated with inappetence and in older cats this commonly results from reduced senses of smell and taste, and/or oral pain associated with periodontal disease[13]. In addition, older cats tend to be less efficient at digesting their food. This probably results from reduced intestinal function, gastric acid production, gastric and intestinal motility, and intestinal blood flow[14,15]. Older cats may also have reduced pancreatic lipase activity and changes in the composition of bile[16]. While these factors effect the digestion of all dietary components they particularly effect the digestion and absorption of fats and proteins[9,16]. There is a striking reduction in the apparent energy digestibility coefficients as cats' age. These coefficients give an indication of how much benefit a cat derives from its food. In cats of less than seven years the coefficients range from 0.8-0.9. However, they can be reduced to as low as 0.65 in some older cats[9]. Most cats will compensate for this by increasing their daily food intake. However, some individuals may need to increase their intake by as much as 25%[9]. Due to the limitation of their stomach capacity this means that they need to eat many small meals a day. Weight loss is likely to result when more frequent meals are not offered or when eating is painful. To compensate for this many older cats may benefit from being fed a highly palatable, highly digestible, energy dense food; and that it is offered in small amounts frequently.

Many of the specific nutrient requirements for older cats have still been determined. It is often assumed that many older cats have some degree of sub-clinical disease, particularly of the kidneys. Because of this it has previously been recommended that older cats should be fed diets with a moderate protein restriction. However, in view of our current understanding of the high protein requirements of cats and the reduced digestive efficiency of old age, it is now felt that inappropriate restriction of dietary protein may risk the development of protein malnutrition. That is, of course, unless the cat has evidence of chronic renal insufficiency (CRI): when it is likely to benefit from moderate protein restriction, moderate phosphorus restriction, and potassium supplementation[17].

Many compounds are currently being studied for their potential to improve the quality and duration of our cats lives. While more research is needed to determine the extent of any potentially positive effects, suggested compounds include increased levels of anti-oxidants and free-radical scavengers (e.g. glutathione, vitamins A, C and E, taurine, carotenoids, and selenium), green-lipped muscle extract, various combinations of essential fatty acids, and many more.

Significant weight changes should always be investigated because weight loss is often the first sign of disease. Interestingly, while many of the diseases seen in older cats are associated with inappetence and a reluctance to eat, this is clearly not always the case. With hyperthyroidism and some of the mal-assimilation syndromes (e.g. inflammatory bowel disease, or early stage gastrointestinal lymphocytic lymphoma) weight loss may be accompanied by a good or even increased appetite. Owners therefore need to know that any alteration in appetite is significant, be it an increase or a decrease.

Changes in environment:
Unfortunately, older cats often cope very poorly with changes in their daily routine. Their response to stress is often to stop eating, hide, and/or alter their toileting habits. Any change within the environment, the family, or even the diet can act as a source of stress. Because a diet changes can, in itself, be stressful it is important to make changes slowly, gradually introducing the new food in a separate bowl, while keeping the old food available. Unfortunately, in some very easily stressed cats diet changes cannot always be made. Because many older cats experience difficulty coping with alterations in their environment it is important to consider this when planning changes. Where possible these should be kept to a minimum, and when they have to be made they should be made slowly and with much reassurance. Some geriatric cats become progressively senile. These cats may benefit from having their area of access reduced, while still containing all necessary facilities. This small area can then be kept safe and constant (see lecture on Cognitive dysfunction syndrome).

Sensitivity to thirst:
As cats age they have reduced sensitivity to thirst. This results in an increased risk of dehydration, especially when combined with excessive urination. The latter is commonly associated with either concurrent chronic renal insufficiency (CRI) or diabetes mellitus (DM), and both of these conditions occur

commonly in older cats. It is often advisable to feed older cats a diet with high water content. However, if cats are unwilling to eat wet food, then it may be helpful to try to increase their fluid intake using other methods. Drinking can be encouraged by ensuring constant access to free water, using bottled water or pet water-fountains, or by giving fishy water or chicken/meat stock (ensure that no onion or onion powder has been added as cats can develop hemolytic anaemia if fed too much onion).

Changes in immune function:
The immune function of all mammals deteriorates with age. While there are only a few studies looking specifically at the effects of ageing on the immune system of cats, these studies do appear to confirm that this is the case. Older cats have significantly lower numbers of total white blood cells (particularly $CD4^+$ lymphocytes), while neutrophil counts are raised[19]. These changes are likely to result in a reduced ability to fight infection or to screen for neoplastic cells. This may explain the increased risk of neoplasia in older cats. While studies are still at a very early stage a number of dietary components are being investigated for their potential to support or even improve the immune function of older animals (e.g. vitamins A and E, selenium, zinc, magnesium, and Co-enzyme Q_{10})[20-23].

The age-related risk of infection can perhaps best be demonstrated by looking at the age-related incidence of bacterial cystitis. Clinical signs suggestive of bladder disease include increased frequency of urination, straining to urinate, blood in the urine, or a blocked urinary tract. In cats under 10 years of age a bacterial cause is found in only 1-2% of cases[24,25]. In the majority of these young cats no obvious cause can be found (although stress and diet may play a role), and some are found to have bladder stones. However, the situation in older cats with cystitis is very different, with almost 50% of cats over 10 years of age having a bacterial cause for their bladder inflammation[26,27]. Some of these infections are related to the general immune senescence associated with age. However, the majority are associated with CRI or DM, both of which are diseases that occur commonly in older cats and which are, in themselves, both locally and systemically immunosuppressive.

Chronic renal insufficiency:
Older animals are susceptible to many diseases and diet has a role to play in the cause and/or management of many of them. Veterinary surgeons most typically list the most common as kidney disease, hyperthyroidism, neoplasia (cancer), dental disease, diabetes mellitus, and arthritis. Arguably, the most significant of these is renal failure.

Advancing age has many ways of damaging cats' kidneys. Some of the factors include a tendency towards mild dehydration, an increased risk of infection (pylonephritis or interstitial nephritis), and an increased risk of acute renal failure secondary to the administration of certain drugs. It is therefore not suppressing that acute and chronic renal failure are both seen very commonly in older cats. However, these are not the only causes of renal failure and we now know that there are a number of dietary factors that can also be detrimental to kidney function. These include over-acidification of the diet[28], the addition of extra salt[29], the inclusion of high levels of ash[30], or the addition of too little potassium[31]. The presence of any of these factors can result in kidney failure, especially when fed to older cats. Interestingly, the first three of these factors are often included in diets that are marketed to help reduce the risk of struvite urolithiasis. Diets that are designed for this purpose should not therefore be fed to older cats. (That is, of course, unless a specific diagnosis of struvite urolithiasis has been made). Interestingly, while both struvite and oxalate uroliths are found quite commonly in younger cats, oxatate uroliths are seen most frequently in older cats. This probably reflects the fact that older cats have significantly lower blood and urine pH levels, and this reduces the risk of struvite urolithiasis while increasing the risk of oxatate urolithiasis[28]. While we do know of some of the nutritional factors that are detrimental to kidney function, we are a long way off defining a diet that actually preserves it.

The importance of arthritis:
Interestingly, most owners list the diseases that they see in their older cats in a different order to the list generated by veterinary surgeons. Top of the list is arthritis, and this is followed by kidney failure, deafness, blindness, hyperthyroidism, bronchitis, and dental problems[32]. The role of arthritic pain in reducing the quality of life for many older cats has probably been significantly underestimated. Many owners report having to adjust their house to assist their older cats; moving food and water bowls to lower surfaces, adding ramps to allow easier access to favoured sleeping areas, and placing low-sided litter boxes within easy cat reach. The increasing importance of arthritis in our older cats is supported by finding radiographic evidence of degenerative joint disease in 90% of cats over 12 years of age[33]. The cause of arthritis is usually multi-factorial; trauma, diet (obesity) and genetics all play a role. Recognising

and addressing these causes, and presence of arthritis, can make a considerable difference to the quality of an older cat's life. While there is a clear role for diet and, in particular, for obesity in the cause of arthritis, a positive role of specific nutrients is still unclear. That said; the potential anti-arthritic properties of a number of different nutritional compounds are currently being studied (e.g. green lipped muscles, and various sources of chrondrin sulphate).

Senior Health Care Clinics:
Many older cats develop clinical illness and the diagnosis and treatment are often complicated by the concurrence of multiple interacting disease processes. Prompt and full investigation is essential if treatment is to be successful. Unfortunately, it is not always easy for owners to recognize the signs of ill health so it is important that they monitor their older cats for changes in food and water consumption, body weight, production of urine and feces, and behaviour. The implementation of Senior Health Care Clinics by primary care veterinary practices can be very beneficial. While the clinics do need to be tailored to individual cats, in general they should include regular and thorough physical examinations (including assessment of body weight, systolic blood pressure, and retinal examination). In addition, a blood sample is usually collected for biochemical screening, thyroid level assessment and haematology and, where appropriate, serological testing for FeLV and/or FIV. A urine sample should undergo routine urinalysis, urine protein to creatinine ratio and, where possible, bacterial culture. Initially, most cats will only need to attend a clinic on a yearly basis. However, those cats showing significant ageing changes may need to attend more frequently; for repeated reassessment, monitoring and treatment.

Changes in physiology:
Once disease has been diagnosed it is important to remember that changes in physiology also affect the pharmacokinetics of many drugs. Most drugs need to be metabolised in some way, and most drug metabolism occurs in the liver and/or kidneys. Liver disease, low levels of blood albumen (which binds to many drugs), and CRI all occur frequently in older cats. When coupled with mild dehydration (which is common in older cats) these can result in reduced clearance rates and marked elevations in circulating drug concentrations[9]. When treating geriatric patients the dose and dosing intervals of some drugs may therefore need to be altered. For example; the dose of metronidazole given for the treatment of suppurative cholangiohepatitis may need to be significantly reduced while the dosing interval of aspirin given in the management of thrombosis associated with hypertrophic cardiomyopathy may need to be increased. However, it is not only drug overdose that needs to be considered. In humans, adverse drug reactions are two to three times more common in people over 60 years of age[24]. The situation is likely to be similar in cats, so we need to be observant when medicating our older cats.

Treat the individual:
While veterinary medicine can often offer complex therapeutic options and sophisticated prescription diets it is important to remember that older cats are often poorly tolerant of the stress of hospitalisation or excessive physical handling. It is essential that each cat be assessed and treated as an individual. In some cases investigations and interventions may have to be adapted or even abandoned if they are poorly tolerated for either medical or temperamental reasons. Also, once our patient's quality of life can no longer be maintained it is important that euthanasia be discussed, and then performed, as compassionately as possible.

While it is true to say that "old age is not a disease", it is important that we pay particular attention to our older cats, feed and care for them appropriately, and observe them closely so we can keep them well, for as long as possible.

Table 1: Shows the approximate correlation between cat and human ages.

Cat's Age	Approximate Human Equivalent
1	16
2	21
3	25 *
4	29
5	33
6	37
'Senior' cats	
7	41
8	45
9	49
10	53
11	57
'Geriatric' cats	
12	61
13	65
14	69
15	73

* From then add 4 years for every year

Table 2: Shows the approximate correlation of cat age to body condition[6-9].

Age of Cat	% too thin	% too fat
1-2 years	< 10	20
2-10 years	< 10	20-50
> 12 years	30-50	< 20

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Considering the Older Cat – Case Studies

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The major diseases seen in older cats are endocrinopathies (such as hyperthyroidism and diabetes mellitus), renal disease, neoplasia, infections (such as FIV), periodontal disease and arthritis. However, older cats can also be affected by diseases more commonly seen in younger animals (such as inflammatory bowel disease). It is important to remember that while young animals usually have only one disorder at a time, this is often not the case with the older patient, where diagnosis and treatment may be complicated by the concurrence of multiple interacting disease processes.

Case 1

Chloe - 11 year old FN Birman cat.

Owner's complaint - Inappetance, weight loss and bad breath.

Clinical findings - Chloe was agitated, in poor body condition, moderately dehydrated, had extensive gingivitis and several severe dental neck lesions. Both kidneys felt small and slightly irregular. A 1x1.5 cm mass to the left side of the neck was presumed to be a thyroid nodule. The apex beat was prominent and a gallop sound was heard on cardiac auscultation. The heart rate was 228 beats/minute. Movement of her left hip elicited pain (historically she had been hit by a car when she was five years old and suffered a fracture of her left femoral neck).

a) Give the problem list, and list the differential diagnoses for the major clinical problem(s).

b) Detail your diagnostic plan

Initial results are shown below:

Haematology			**Biochemistry**		
RBC	7.20	(5.5-10.0 10^{12}/l)	Total Protein	61.1	(69-79 g/l)
PCV	29.2	(24-45 %)	Albumin	28.3	(28-39 g/l)
Haemoglobin	10.6	(8.0-14.0 g/dl)	Globulin	31.8	(23-50 g/l)
MCV	45.2	(39-55 fl)	Urea	14.6	(2.8-9.8 mmol/l)
WBC	21.3	(7.0-20.0 10^9/l)	Creatinine	205	(40-177 umol/l)
Neutrophils	14.6	(2.5-12.8 10^9/l)	ALT	257	(15-60 u/l)
Band neuts.	4.2	(0.0-0.3 10^9/l)	ALP	146	(10-100 u/l)
Lymphocytes	1.8	(1.5-7.5 10^9/l)	Bile acids	12.4	(0.0-7.0 umol/l)
Monocytes	0.7	(0.07-0.85 10^9/l)	Glucose	7.1	(3.3-5.0 mmol/l)
Eosinophils	0.0	(0.0-1.0 10^9/l)	Ca	2.2	(2.1-2.9 mmol/l)
Platelets	250	(300-600 10^9/l)	PO_4	2.5	(1.4-2.5 mmol/l)
			K	4.6	(4.0-5.0 mmol/l)
Film:			Na	148	(145-156 mmol/l)
No abnormal cells seen			Thyroxine	176	(19-65 nmol/l)
Some platelet clumping					

Urinalysis (cystocentesis)

pH	6.8
SG	1.025
Glucose	-ve
Ketones	-ve
Protein	++

Otherwise unremarkable

Systolic blood pressure

195 (<180 mmHg)

c) What is your interpretation of these findings?

- Because she was very difficult to handle Chloe was sedated with a low dose of acepromazine and pethidine to allow further investigation, and IV fluid therapy was initiated.
- Abdominal radiographs confirmed rather small and irregular renal silhouettes.
- Renal ultrasound examination confirmed the presence of bilaterally small and irregular kidneys, which lack corticomedulary detail and had irregular cortical outline.
- Her liver was slightly heterogeneous on ultrasound examination.
- Thoracic radiographs revealed a rather tall heart on the lateral view which was wide on the DV view.
- ECG examination showed tall QRS complexes, and echocardiology examination found evidence of moderate hypertrophic cardiomyopathy (HCM); mild dilation of the left atrium and hypertrophy of the left ventricle.

d) What is your diagnosis?

e) Would you have performed the investigation as above? If not, what modifications would you have made?

f) How would you progress with this case?

Initial treatment consisted of:

- Carbimazole (5mg po q8h), propranolol (5mg po q12h) and amoxycillin/clavulanate (50mg po q12h).

After 2 weeks:

- Serum thyroxine 65 nmol/l.
- Systolic blood pressure 175 mmHg.
- General anaesthesia was undertaken to allow for unilateral thyroidectomy and dental extractions/descaling.
- Low dose acepromazine and pethidine, iv fluids, iv propofol, maintained with isofluorane, nitrous oxide and oxygen.

g) How would your treatment regime have differed from this?

h) Would you have undertaken any monitoring during the treatment (other than during the anaesthesia)?

If so, what, how often, and why?

Follow-up treatment:

- Stopped carbimazole, but remained on antibiotics for another week.
- 1 day postoperatively - heart rate 180 beats/minute and systolic blood pressure 175 mmHg - so stopped propranolol.
- 3 months post-operatively - cardiac hypertrophy resolved and liver parameters returned to normal.
- 2 years later - Chloe continues to do quite well, although with progressive signs of renal insufficiency. Recurrent dental infection has warranted further courses of antibiotics.
- However, progressive arthritis in her left hip causes her more pain and immobility.

i) What was the most likely cause(s) of the systemic hypertension?

j) How would you try to treat her arthritis?

Case 2

Cardhu - 8 years old MN DLH

History - He is a fully indoor cat. His owners noticed possible polydipsia and an increased weight to the litter in the litter box over the preceding 6 months. In addition, they had also noticed occasional episodes of halitosis, anorexia and lethargy ('off days').

Clinical examination - This revealed a cat in good body condition. His heart rate was160 beats per minute, with no gallops or murmurs. He had mild gingivitis and a possible thyroid nodule on the left hand side. He had a normal respiratory rate, and his chest and abdomen were unremarkable on palpation.

a) Give the problem list, and list the differential diagnoses for the major clinical problem(s).

b) Detail your diagnostic plan

Initial results are shown below:

Haematology

RBC	6.10	(5.5-10.0 10^{12}/l)
PCV	25.2	(24-45 %)
Haemoglobin	9.6	(8.0-14.0 g/dl)
MCV	40.2	(39-55 fl)
WBC	9.4	(7.0-20.0 10^9/l)
Neutrophils	6.2	(2.5-12.8 10^9/l)
Band neuts.	0.0	(0.0-0.3 10^9/l)
Lymphocytes	3.2	(1.5-7.5 10^9/l)
Monocytes	0.	(0.07-0.85 10^9/l)
Eosinophils	0.0	(0.0-1.0 10^9/l)
Platelets	240	(300-600 10^9/l)

Film:
No abnormal cells seen
Some platelet clumping

Biochemistry

Total Protein	61.0	(69-79 g/l)
Albumin	28.2	(28-39 g/l)
Globulin	32.8	(23-50 g/l)
Urea	15.6	(2.8-9.8 mmol/l)
Creatinine	192	(40-177 umol/l)
ALT	56	(15-60 u/l)
ALP	78	(10-100 u/l)
Bile acids	3.5	(0.0-7.0 umol/l)
Glucose	7.3	(3.3-5.0 mmol/l)
Ca	2.4	(2.1-2.9 mmol/l)
PO_4	2.1	(1.4-2.5 mmol/l)
K	4.6	(4.0-5.0 mmol/l)
Na	150	(145-156 mmol/l)
Thyroxine	33	(19-65 nmol/l)

Urinalysis (cystocentesis)

pH	8.2
SG	1.027
Glucose	-ve
Ketones	-ve
Protein	+++
Lipid droplets	

Systolic blood pressure
200 (<180 mmHg)

c) What is your interpretation of these findings?

d) How would you treat this case, and why?

Three months later Cardhu returned for a routine revisit.
His owner reported that he was generally doing quite well, but he was currently having one of his 'off days'. However, other that that they said that he was generally less polyuric and polydipsic, and was eating well. Clinical examination revealed no changes from the previous visit.

e) What investigations would you undertake at this time?

Initial results are shown below:

Haematology

RBC	6.90	(5.5-10.0 10^{12}/l)
PCV	25.9	(24-45 %)
Haemoglobin	10.3	(8.0-14.0 g/dl)
MCV	39.1	(39-55 fl)
WBC	9.6	(7.0-20.0 10^9/l)
Neutrophils	6.4	(2.5-12.8 10^9/l)
Band neuts.	0.0	(0.0-0.3 10^9/l)
Lymphocytes	3.2	(1.5-7.5 10^9/l)
Monocytes	0.	(0.07-0.85 10^9/l)
Eosinophils	0.0	(0.0-1.0 10^9/l)
Platelets	250	(300-600 10^9/l)

Film:
No abnormal cells seen
Some platelet clumping

Biochemistry

Total Protein	67.4	(69-79 g/l)
Albumin	36.2	(28-39 g/l)
Globulin	31.2	(23-50 g/l)
Urea	17.3	(2.8-9.8 mmol/l)
Creatinine	200	(40-177 umol/l)
ALT	63	(15-60 u/l)
ALP	76	(10-100 u/l)
Bile acids	3.6	(0.0-7.0 umol/l)
Glucose	7.6	(3.3-5.0 mmol/l)
Ca	2.3	(2.1-2.9 mmol/l)
PO_4	2.5	(1.4-2.5 mmol/l)
K	4.7	(4.0-5.0 mmol/l)
Na	148	(145-156 mmol/l)
Thyroxine	35	(19-65 nmol/l)

Urinalysis (cystocentesis)

pH	8.2
SG	1.030
Glucose	-ve
Ketones	-ve
Protein	+

Lipid droplets
Occasional white blood cells, occasional casts, and bacteria

Systolic blood pressure
170 (<180 mmHg)

Urine protein:creatinine 0.09

f) What is your interpretation of these findings?

g) Would you change your treatment of this case? If so, how?

h) What is the long term prognosis, and how would you monitor this case?

Case 3

Jack - 12 year old MN DSH

Owner's complaint - Sudden onset of blindness and disorientation. The cat had also been losing weight slowly over the past few months, was less keen to eat and possibly polydipsic.

Physical examination - The cat had a poor body condition, was slightly dehydrated, had moderate gingivitis and rather irregular small kidneys. He had a wide-based stance, had bilaterally fixed dilated pupils, lacked "menace" and pupillary light responses and appeared to be blind. Retinal examination revealed retinal haemorrhages, oedema and partial detachment, plus dilation and constriction of primary retinal venules.

a) Give the problem list, and list the differential diagnoses for the major clinical problem(s).

b) Detail your diagnostic plan

Initial results are shown below:

Haematology

RBC	4.20	(5.5-10.0 10^{12}/l)
PCV	18.1	(24-45 %)
Haemoglobin	6.6	(8.0-14.0 g/dl)
MCV	35.5	(39-55 fl)
WBC	7.9	(7.0-20.0 10^9/l)
Neutrophils	6.5	(2.5-12.8 10^9/l)
Band neuts.	0.0	(0.0-0.3 10^9/l)
Lymphocytes	1.4	(1.5-7.5 10^9/l)
Monocytes	0.	(0.07-0.85 10^9/l)
Eosinophils	0.0	(0.0-1.0 10^9/l)
Platelets	180	(300-600 10^9/l)

Film:
No abnormal cells seen
Some platelet clumping

Biochemistry

Total Protein	63.9	(69-79 g/l)
Albumin	29.9	(28-39 g/l)
Globulin	34.0	(23-50 g/l)
Urea	20.0	(2.8-9.8 mmol/l)
Creatinine	198	(40-177 umol/l)
ALT	62	(15-60 u/l)
ALP	77	(10-100 u/l)
Bile acids	7.3	(0.0-7.0 umol/l)
Glucose	9.2	(3.3-5.0 mmol/l)
Ca	2.2	(2.1-2.9 mmol/l)
PO_4	5.3	(1.4-2.5 mmol/l)
K	4.0	(4.0-5.0 mmol/l)
Na	149	(145-156 mmol/l)
Thyroxine	23	(19-65 nmol/l)

Urinalysis (cystocentesis)

pH	6.7
SG	1.025
Glucose	-ve
Ketones	-ve
Protein	+

Lipid droplets
Sterile

Systolic blood pressure
210-230 (<180 mmHg)

Radiography revealed both kidneys to be rather small and slightly irregular. Renal ultrasonography confirmed this and revealed bilaterally reduced corticomedullary detail.

c) What is your interpretation of these findings?

d) How would you initially treat this case?

e) How would you manage this case long-term?

Case 4

Chloe - 11-year-old FN DSH cat

History - 5 year history of haematuria and dysuria. Usually episodic, but now very severe.

Clinical examination - Unremarkable except for a firm, rather painful, mid-sized bladder.

a) Give the problem list, and list the differential diagnoses for the major clinical problem(s).

b) Detail your diagnostic plan

Initial haematology and serum biochemistry (including thyroxine) unremarkable. Systolic blood pressure normal.

Urinalysis (cystocentesis)

pH	7.1
SG	1.040
Glucose	-ve
Ketones	-ve
Protein	++
Red blood cells	+++
White blood cells	++
Sterile	

See lecture for radiographs, ultrasound images, cystoscopic pictures and cytology.

c) What is your interpretation of these findings and how would you progress with this case?

d) What is your diagnosis and how could you treat this case?

Case 5

Benji - 14 year old MN DLH

History - Benji was presented with a 2-3 week history of urinating outside his litter box. However, there was no obvious evidence of haematuria. Otherwise, his owner's had noticed some weight loss, despite a generally good appetite. They had also noticed that his coat had lost some of its condition, and he was perhaps drinking and sleeping more than usual.

Physical examination - Good body condition, mild gingivitis, otherwise unremarkable.

a) Give the problem list, and list the differential diagnoses for the major clinical problem(s).

b) Detail your diagnostic plan

Initial results are shown below:

Haematology

RBC	7.10	(5.5-10.0 10^{12}/l)
PCV	28.2	(24-45 %)
Haemoglobin	11.6	(8.0-14.0 g/dl)
MCV	44.2	(39-55 fl)
WBC	8.3	(7.0-20.0 10^9/l)
Neutrophils	5.1	(2.5-12.8 10^9/l)
Band neuts.	0.0	(0.0-0.3 10^9/l)
Lymphocytes	3.2	(1.5-7.5 10^9/l)
Monocytes	0.0	(0.07-0.85 10^9/l)
Eosinophils	0.0	(0.0-1.0 10^9/l)
Platelets	240	(300-600 10^9/l)

Film:
No abnormal cells seen
Some platelet clumping

Biochemistry

Total Protein	68.1	(69-79 g/l)
Albumin	35.3	(28-39 g/l)
Globulin	32.8	(23-50 g/l)
Urea	17.6	(2.8-9.8 mmol/l)
Creatinine	199	(40-177 umol/l)
ALT	414	(15-60 u/l)
ALP	111	(10-100 u/l)
Bile acids	6.5	(0.0-7.0 umol/l)
Glucose	23.2	(3.3-5.0 mmol/l)
Ca	2.3	(2.1-2.9 mmol/l)
PO_4	2.0	(1.4-2.5 mmol/l)
K	4.7	(4.0-5.0 mmol/l)
Na	152	(145-156 mmol/l)
Thyroxine	32	(19-65 nmol/l)

Urinalysis (cystocentesis)

pH	8.2
SG	1.035
Glucose	+++
Ketones	-ve
Protein	++
Lipid droplets	
White blood cells	
Bacteria	

Systolic blood pressure
175 (<180 mmHg)

Serum fructosamine
560 (220-350 mmol/l)

c) What is your interpretation of these findings?

Results of other investigations are detailed below:

- Radiography of the chest and abdomen were unremarkable.
- Ultrasonography revealed changes suggestive of a large (possibly fat infiltrated) liver, moderate extrahepatic bilary tract obstruction (EHBO)(i.e. distended, 'sludge'-filled gall bladder, and tortuous biliary tree), an irregular heterogeneous pancreas, and possible peri-pancreatic fat necrosis. Both kidneys revealed a slight loss of corticomedulary detail, while the rest of the abdominal contents were unremarkable.
- Serum feline trypsin-like immunoreactivity (fTLI) was assessed at the Texas GI lab, and found to be elevated (142 ug/l; reference range 12-82), while cobalamin (B12) and folate were within normal limits.

This gives additional diagnoses of pancreatitis, moderate EHBO, and probable hepatic lipidosis.

Initial treatment consisted of:
Lenti insulin 2 IU SQ q12h
Marbofloxacin 2 mg/kg PO q24h
Ursodeoxycholic acid (UDCA - Destolite®) 10 mg/kg PO q24h
Hepatosyl (SAMe, Vit K, Vit E) contents of one capsule daily

d) How long would you recommend that each of these medications be given, and why?

e) How would you like to monitor Benji's progress, and how often?

f) What diet would you recommend, and why?

Six months after the initial presentation Benji is re-presented to your clinic. He is collapsed and very dehydrated. His owner's thought that he had been a little 'off colour' for the last week, but noted nothing very obvious. When they got up this morning they found him like this.

g) What are the major medical problems that you would immediately consider?

The Diagnosis & Treatment of Renal Insufficiency in Cats

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1. INTRODUCTION

Chronic renal insufficiency (CRI) is a common and important cause of morbidity and mortality in cats. It can be seen in cats of all ages, but occurs most commonly as an acquired disease of middle-aged to older cats. CRI and chronic renal failure (CRF) are believed to be two to three times more common in cats than dogs. Increasingly, with the routine use of plasma biochemistry testing, more and more cats are being found to be azotaemic. Azotaemia refers to increased levels of plasma creatinine and urea. These begin to rise when the glomerular filtration rate (GFR) is no longer able to maintain normal excretory function. Unfortunately, the relationship between plasma creatinine and GFR is curvilinear. So the GFR may decrease rapidly in the early stages of CRI without incurring increases in creatinine, then, later on even small reductions in GFR may cause dramatic increases in creatinine. It is generally accepted that more than three-quarters of functioning renal tissue must be lost before azotaemia becomes apparent (Finco et al 1995; Squires 1996).

The classification of CRF into clinical stages can be very helpful. However, it is important to look at all of the abnormal clinical findings, and not concentrate on the urea and creatinine levels alone. That said, cats with CRF can usually be divided into:

- Chronic renal insufficiency (nonazotaemia renal failure) - ~2/3 of kidney function lost. Urine concentration ability is reduced, but urea and creatinine levels are still within normal limits.
- Azotaemia renal failure - ~3/4 of kidney function lost. Urea and creatinine levels are raised. Phosphate levels are usually raised. However, initially the cat is not necessarily ill.
- Uraemia renal failure - >3/4 of kidney function lost. The urea, creatinine and other nitrogenous waste products are raised. Synthesis of calcitriol and erythropoietin are usually impaired. The cat is systemically ill.

In 1998, with the support of Novartis Animal Health, the International Renal Interest Society (IRIS) was formed. It was established in recognition of the importance of renal disease in small animal practice, and aims to help veterinary practitioners to better understand, diagnose and treat renal disease in cats and dogs. (For more information on IRIS visit: www.renalhealth.org).

This article will very briefly discuss the aetiology, clinical signs and diagnosis of feline CRF, after which it will focus more deeply on possible long-term management options.

2. AETIOLOGY

While the underlying cause of most cases of feline CRF remains obscure, a number of different aetiologies have been documented (Table 1). The most common histopathological finding is of chronic interstitial nephritis (Lucke 1968), however, the cause of this is uncertain, but in some cases may involve chronic pyelonephritis or glomerulonephritis.

3. CLINICAL SIGNS

The clinical signs of cats with CRF are often non-specific, with dehydration, anorexia, lethargy and depression being seen most commonly (see Table 2) (Lulich et al 1992; Krawiec and Gelberg 1989; DiBartola et al 1987; Elliott and Barber 1998). Polyuria and polydipsia are seen less commonly than in the dog. This may result in part from poor recognition on the part of the owners, but also because cats with CRF often retain some degree of urine-concentrating ability. The presence of small kidneys cannot be relied on as an indicator of CRF as many cats have enlarged kidneys due renal lymphosarcoma or polycystic kidney disease. Other manifestations of uraemia in cats include

vomiting (due to uraemic gastritis, hypergastrinaemia, or the central effects of uraemia toxins), pale mucous membranes (due to anaemia - see below), and hypertensive retinopathy (see below).

4. DIAGNOSIS

Diagnosis of CRF is usually based on clinical signs plus the presence of azotaemia and inappropriately concentrated urine. However, because cats often retain some ability to concentrate their urine it is not necessary to document isosthenuria (SG ~ 1.010). In fact, while most cats with CRF fail to concentrate their urine above 1.035, isosthenuria is seen in only ~60% of cases (Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998).

Azotaemia is not always caused by CRF, and a single blood sample showing an increase in creatinine and/or urea should not be over-interpreted. Serum creatinine may also be increased because of dehydration (pre-renal azotaemia), intestinal absorption of exogenous creatinine (e.g. a cooked meat diet), or a marked increase in body muscle mass (IRIS 2000). Urea may be increased because dehydration, intestinal absorption of exogenous protein (e.g. a high protein diet or gastrointestinal haemorrhage), certain catabolic states (starvation, hyperthyroidism, or the use of corticosteroids), or post-renal failure/obstruction. Once azotaemia has been detected its continued presence should be confirmed with further blood samples and a urine sample should be collected for assessment of its concentration.

In addition to azotaemia, a number of other clinicopathological changes are seen commonly in cats with CRF (Table 3) (Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998). These include hyperphosphataemia (due to reduced GFR), acidosis (because the kidneys fail to excrete sufficient acid), hypokalaemia (due to inappropriate kaliuresis) and hypoproliferative anaemia (due to reduced erythropoetin production, reduced red blood cell survival times, uraemic suppression of erythropoiesis, and/or gastrointestinal bleeding). Other changes may relate to stress and/or dehydration (e.g. altered white blood cell numbers, hyperglycaemia, hyperproteinaemia).

While CRF is usually progressive, some cats may have long periods of relatively stable renal function in both experimental (Ross et al 1982; Adams et al 1994) and naturally occurring disease (Elliott and Barber 1998). Because of this it can be difficult to give an accurate prognosis for a particular cat with CRF. The plasma creatinine concentration is a weak prognostic indicator. In contrast, the presence of anaemia tends to indicate a poor prognosis. Also, cats in end-stage renal failure are more likely to be hyperkalaemic and/or acidotic, have lower urine specific gravity and more acidic urine (Elliott and Barber 1998). End-stage renal failure is also more likely to be associated with worsening renal secondary hyperparathyroidism (RHPTH), reduced levels of calcitriol and reduced levels of ionised calcium (Barber and Elliott 1998).

While it would be advantageous to detect CRI as soon as it develops, this can only be performed where GFR can be measured. Unfortunately, while a number of suitable techniques have been validated (e.g. measurement of GFR using the clearance of inulin, iohexol, Tc-DTPA, or exogenous creatinine) they are not currently routinely available.

It is essential when making a diagnosis of CRF that a full and thorough diagnostic investigation be made. It is important to remember that while young animals usually have only one disorder at a time, this is often not the case with the older patient. In older patients the diagnosis and treatment of CRF may be complicated by the concurrence of multiple interacting disease processes. It is only be detecting and treating the concurrent diseases at the same time as the CRF that the cat can best be managed.

The initial investigation should include a thorough physical examination (including ocular examination, measurement of body weight and systolic blood pressure), plus collection of a blood sample (for routine biochemical and haematological analysis), and a urine sample (for routine urinalysis, and bacterial culture).

5. MEDICAL MANAGEMENT

Where an underlying cause for the CRF can be found this should be addressed. For example, bacterial nephritis or pyelonephritis should be treated with appropriate antibiotics, nephrotoxic drugs should be removed (e.g. non-steroidal anti-inflammatory drugs or aminoglycoside antibiotics), pre-

renal complications should be corrected (e.g. dehydration or cardiac disease), and post-renal obstruction should be resolved. The rest of this section will consider the aetiology of some of the more important problems associated with CRF, then discuss the pros, cons and practical application of possible treatment options.

5.1 The importance of maintaining sufficient fluid intake

An inadequate fluid intake can result in dehydration, reduced renal perfusion and exacerbation of CRF. Some cats may be presented with acute decompensation of their CRF, while others may experience chronic or recurrent dehydration. Maintaining an adequate fluid intake is therefore of prime importance. Owners should ensure that their cat has constant access to fresh water, plus encourage further fluid consumption by feeding a moist diet, and offering tempting 'soups'. Where this proves insufficient to meet the cat's needs many clinicians encourage the regular 'at home' administration of subcutaneous fluids by the owners. While many clinicians supply lactated Ringer's solution (LRS) or normal saline, others prefer to use various combinations that contain lower levels of sodium. The amount of fluid to be given can be adjusted according to need (~100-150 ml, given from daily to once a week). To ease the administration of supplementary fluids the use of 'indwelling' subcutaneous catheters is now gaining favour, as is the use of nasogastric or percutaneously placed gastrotomy (PEG) tubes.

Evidence to support clinical benefit	*Good*
Evidence to support role in preventing progression of CRF	*None*

5.2 The role of diet; including altering the levels of protein and phosphate

Dietary therapy represents the cornerstone of management for patients with CRF. This is because the list of factors within food that may exacerbate or protect against CRF is endless. Most work has concentrated on the roles of protein, phosphate, calcium, potassium, and acidification (see below). However, other studies have suggested that it may be beneficial to restrict sodium chloride (Dworkin et al 1996); to change the lipid content of the diet or alter the balance of free fatty acids (from omega-6 unsaturated fatty acids in favour of omega-3 unsaturated fatty acids) (Brown et al 1996a and b; Finco et al 2000); or to add extra water soluble vitamins (e.g. B-complex vitamins).

The ideal 'renal diet' should therefore:

- Meet nutrient and energy requirements
- Reduce protein catabolism and alleviate clinical signs of uraemia
- Minimise electrolyte, vitamin and mineral disturbances
- Slow the progression of renal failure

5.2.1 Restriction of dietary protein

The clinical benefits of protein restriction in CRF have been demonstrated in a number of species (Harte et al 1994; Finco et al 1992; Levey et al 1999; Polzin et al 1991). The products of protein catabolism are believed to contribute significantly to the clinical signs associated with ureamia. Reducing the intake of non-essential protein may therefore help to reduce the production of nitrogenous waste and so reduce the severity of the anorexia, vomiting, weight loss, anaemia and lethargy.

Whether or not dietary protein restriction actually helps to reduce the progression of renal failure is more controversial. Experimental studies (mostly in rats and dogs) have shown that in the early stages of CRF a declining number of nephrons is compensated for by an increased GFR for each individual (single) nephron (SNGFR). This increase in SNGFR is achieved by glomerular hyperfiltration, glomerular hypertrophy and glomerular hypertension, and is associated with an increase in proteinuria. Together, these factors may lead to glomerular and tubulointerstitial sclerosis and progression of the CRF. In some experimental models protein restriction has minimised these changes and so retarded the progression of disease (Brown and Brown 1995; Polzin et al 1991). While these findings have been supported by a meta-analysis of several studies in humans (Pedrini et al 1996) there is still considerable debate as to whether or not protein restriction will truly limit the progression of CRF in naturally occurring CRF in most species.

Few studies have investigated the role of protein restriction in cats with CRF. One experimental study appeared to show significant proteinuria and glomerular morphological injury in cats fed a higher protein diet, however, the presence of increased protein and calorie intake made interpretation difficult (Adams et al 1994). The difficulty of separating out different dietary variables also proved a complicating factor in studies by Harte et al (1994) and Elliott et al (2000) where cats with naturally occurring CRF were fed diets restricted in protein and phosphorus. In both studies, the cats fed a 'restricted protein-phosphorus diet' showed marked clinical improvement, and reduced levels of plasma urea and phosphate. In the study by Elliott et al (2000) the benefits also included a prolongation of life compared to those fed a standard cat food (mean survival time of 633 versus 264 days). While the overall benefit of the restricted diets cannot be denied, the individual effects of the protein and phosphorus cannot be determined.

It is generally recommended that cats with CRF be fed a diet with moderate protein restriction; containing protein of ~20% of the caloric intake. Unfortunately, the exact requirements are unknown, and since cats have a naturally high protein requirement it is essential not too over restrict them (Polzin et al 1996). It is also important to ensure that the source of protein is of high biological value and contains all of the essential amino acids.

Unfortunately, while feeding a moderately protein-restricted diet is recommended, the poor palatability of these diets often limits their acceptance. Because of this, it is often recommended that cats with CRF be gradually weaned onto these diets before they start becoming inappetent or anorexic.

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *Poor*

5.2.2 Restriction of dietary phosphorus and use of phosphate binders

Hyperphosphataemia occurs in approximately two thirds of cats with CRF (Table 3)(Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998), and is believed to contribute to the uraemic complication of CRF. The primary mechanism for hyperphosphataemia is phosphate retention due to reduced GFR. Because the regulation of phosphorus and calcium are intrinsically linked, the phosphorus retention leads to calcium-phosphate deposition in the tissues (metastatic mineralisation), and this, in turn, leads to a reduction in the concentration of plasma ionised calcium. The resultant hypocalcaemia, although subclinical, stimulates the release of parathyroid hormone (PTH). Phosphate retention, when combined with the loss of renal mass, leads to a decreased production and/or activity of renal 1-• -hydroxylase enzyme, and hence a reduction of 1,25 dihydroxyvitamin D (calcitriol). The hypocalcitriolaemia results in a further increase in PTH production and reduced intestinal absorption of calcium. Phosphorus retention is therefore an important factor in the development of renal secondary hyperparathyroidism (RHPTH) (Chew et al 1992).

Secondary hyperparathyroidism occurs commonly in cats with CRF. In one study, 84% of cats with naturally occurring CRF were found to have RHPTH; with the severity and prevalence being highest in cats with end-stage renal failure (Barber and Elliott 1998).

Parathyroid hormone may be considered as a ureamic toxin. In excess, it has been associated with a variety of clinical abnormalities, including anaemia, neurotoxicity, osteodystrophy (resulting in low-grade bone pain), arthritis, glucose intolerance, hyperlipidaemia, pancreatitis, immunosuppression and soft tissue mineralisation. While it is clear that when soft tissue mineralisation involves the kidneys it can lead to progressive renal dysfunction, a more general role for PTH in the progression of CRF is still under debate (Chew and Nagode 1992).

Limiting phosphorus consumption appears to slow the progression of CRF. Experimentally, when cats with CRF were fed a diet restricted in phosphate, they developed less renal mineralisation, mononuclear cell infiltration and fibrosis than cats fed a normal diet (Ross et al 1982). Studies in dogs have also shown a beneficial effect to restricting dietary phosphorus once azotaemia develops (Finco et al 1992). As discussed above, (under 'Restriction of dietary protein'), feeding cats with naturally occurring CRF a diet restricted in both phosphate and protein resulted in a marked clinical improvement, plus reduction of plasma phosphorus and PTH (Barber et al 1999; Elliott et al 2000). Since PTH is believed to be a ureamic toxin reducing its concentration is likely to be beneficial

(Barber et al 1999). Interestingly, RHPTH can occur prior to the development of overt hyperphosphataemia. However, the importance of starting phosphate restriction prior to the detection of increased circulating phosphate remains unclear (Barber et al 1999).

Restriction of dietary phosphate is an important part of CRF management. The aim is to normalise the serum phosphate concentration. This can initially be achieved by feeding a phosphate-restricted diet (most commercial 'renal diets' are low in protein and therefore also low in phosphorus). However, when that is no longer sufficient, intestinal phosphate binders will need to be added. Monitoring plasma phosphate is an efficient, if not very sensitive, method for the detection of RHPTH (Barber and Elliott 1998). That said, blood samples should be collected after a 12 hour fast and should be non-haemolised. A more sensitive method is to directly assess PTH concentration (Barber and Elliott 1998), however, this requires a fasted blood sample, 'frozen shipment' of serum and access to a species-validated test, which is usually expensive.

Intestinal phosphate binders are usually added once the fasting serum phosphorous is > 2 mmol/l. Aluminium hydroxide, aluminium carbonate or aluminium oxide are used most commonly (30-150 mg/kg/day, divided between meals, and adjusted according to response). Unfortunately, phosphate binders are often poorly palatable, messy to administer, and may lead to nausea, anorexia, or constipation. Also, in humans, it has been shown that the aluminium may become deposited in bone, resulting in worsening renal osteopathy. While this has not been shown to occur in dogs (Finco et al 2000), the situation in cats is unknown. Because of this, some clinicians have recommend the use of calcium salts e.g. calcium carbonate (20-100 mg/kg/day, divided between meals), or calcium acetate. However, they are less effective than aluminium salts, and they have the potential to induce hypercalcaemia. When using calcium salts it is essential to normalise the calcium level before starting medication, and to monitor it closely throughout therapy. Since hypophosphataemia can result in weakness and anaemia, it is important to monitor phosphate levels whichever type of phosphate binder is chosen.

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *Poor*

5.2.3 Calcitriol therapy

Plasma calcitiol concentrations are reduced in cats with CRF (see above) (Barber and Elliott 1998). Since calcitriol therapy effectively reduces PTH levels it should, in theory, make a useful adjunct to the treatment of cats with CRF (Chew and Nagode 1992). Some clinicians use calcitriol therapy extensively, and claim that it improves their patients' appetite and general well being (1.5-3.5 ng/kg/day, given separately from meals) (Nagode et al 1996). However, there are few controlled studies showing beneficial long-term use. Also, the difficulties associated with its administration and monitoring deter many clinicians from using it. Careful monitoring is essential because calcitriol administration can result in hypercalcaemia and resultant hypercalcaemic nephropathy. Calcium and phosphorous levels must be in the low-normal range before beginning treatment, and they should then be monitored every 2-4 weeks.

Evidence to support clinical benefit *Poor?*
Evidence to support role in preventing progression of CRF *Poor*

5.3 Control of hypokalaemia

Hypokalaemia, probably resulting from inappropriate kaliuresis, is a common finding in cats with CRF (Table 3)(Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998). It is currently unclear whether hypokalaemia is a cause of CRF, a consequence of CRF, or both. However, there is good evidence to show that hypokalaemia can cause or exacerbate feline CRF (DiBartola et al 1993; Dow et al 1990), and potassium supplementation of hypokalaemic cats with CRF often results in improved renal function (Dow et al 1987).

While the most obvious sign of severe hypokalaemia is polymyopathy, with generalised muscle weakness and ventroflexion of the neck, this does not develop until there is severe potassium depletion. Routine assessment of serum potassium is therefore recommended, with supplementation where necessary. Since feeding acidifying, magnesium restricted, and/or high protein diets appears to increase the risk of hypokalaemia these should not be fed to cats with CRF. Instead, it is advisable

to feed non-acidifying, protein-restricted diets, and supplementation is recommended if the serum potassium levels fall below 4 mmol/l. Potassium gluconate is used most frequently (initially at 1-4 mmol q12h po, reducing as required). However, potassium citrate may be preferable when the patient is also acidotic (75 mg/kg q12h po). Potassium chloride is used infrequently as it is unpalatable and may cause gastrointestinal irritation. Daily potassium supplementation of non-hypokalaemic cats with CRF does not appear to be beneficial (Theisen et al 1997).

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *Good*

5.4 Correction of acidosis

Reduced renal function leads to a decline in the renal capacity for acid excretion. Because of this, acidosis occurs fairly commonly in cats with CRF, particularly those with severe disease (Table 3)(Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998). While acidosis is believed to contribute to anorexia, nausea, vomiting, weight loss, lethargy, and hypokalaemia, its role in the progression of renal failure remains unclear (Polzin et al 2000). That said, in other species it is associated with increased protein catabolism, anorexia, and precipitation of uraemic crisis (Fettman et al 1992), and, enhanced renal ammoniagenesis can cause activation of the complement cascade and tubulointerstitial injury (Nath et al 1985).

It is advisable to monitor cats with CRF at regular intervals for their acid-base status (assess TCO_2 or plasma bicarbonate). Specific treatment should be considered when TCO_2 is < 15 mmol/l, and should aim to maintain the TCO_2 between 18-23 mmol/l (Finco et al 2000). Treatment most frequently consists of sodium bicarbonate (5-10 mg/kg q8-12h po) or potassium citrate (30 mg/kg q12h po). However, sodium bicarbonate should be used cautiously in hypertensive patients, and potassium citrate may be a better choice when hypokalaemia is also present.

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *None*

5.5 Correction of hypoproliferative anaemia

Many cats with CRF develop progressive anaemia that results in a variety of clinical signs including lethargy, inappetence, weakness and weight loss (Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998). The cause of the anaemia is multifactorial, and includes reduced erythropoetin production related to reduced renal mass, reduced red blood cell survival times, uraemic suppression of erythropoiesis, and/or gastrointestinal bleeding. The most commonly used treatment options include recombinant human erythropoietin (r-HuEPO), iron supplementation (if needed), and anabolic steroids.

A number of studies have shown that r-HuEPO can cause a dramatic reversal of anaemia in cats with CRF, along with a general improvement in well being (Cowgill 1994; Polzin et al 1992). Treatment with r-HuEPO is usually started once the PCV has fallen below ~20% (100 units/kg is given subcutaneously three times a week until the PCV reaches ~30%, after which the dosage interval can be extended. Initially, the PCV and other red cell parameters should be monitored weekly, then once the cat is more stable this can be extended to perhaps once every three to four weeks. If further adjustments are needed the dose can be altered by 25-50 units/cat)(Cowgill 1994). Complications to r-HuEPO therapy include poor response due to iron deficiency, hypertension, polycythaemia, induction of anti-r-HuEPO antibodies, and systemic or local allergic reactions. To reduce the risk of iron deficiency it is sensible to assess serum iron levels and total iron binding capacity prior to starting treatment, and to continue to monitor these parameters while the cat is receiving r-HuEPO. If iron supplementation is required ferrous sulphate can be given (50-100 mg/cat q24h po). About 30% of cats treated with r-HuEPO eventually develop antibodies that prevent the r-HuEPO from inducing erythropoiesis and can, occasionally, result in transfusion dependent aplastic anaemia. Its relatively high cost, the risk of side effects, and the cost of the necessary monitoring often limit the use of r-HuEPO.

While some clinicians advocate the use of anabolic steroids (e.g. nandrolone decanoate 1-1.5 mg/kg weekly by intramuscular injection) experimental support for their use is generally poor (Polzin et al 1992).

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *None*

5.6 Support of adequate food intake: Control of nausea and vomiting, use of gut protectants, appetite stimulants, and intake supplementation

Cats with CRF often have a reduced food intake. Their lack of appetite may be caused by uraemic gastritis (due to the effects of circulating uraemic toxins or hypergastrinaemia), gastrointestinal haemorrhage, or the central effects of uraemic toxins causing nausea and vomiting. Offering rather unpalatable 'renal diets' often exacerbates the inappetence. Cats that do not maintain their food intake may incur protein malnutrition, endogenous protein catabolism, and metabolic acidosis.

Treatment options include the use of H_2-antagonists to reduce gastric acidity (e.g. ranitidine 2-4 mg/kg q12h, iv or po, famotidine 0.5-1.0 mg/kg q24-48h po [not iv], or cimetidine 2.5-5.0 mg/kg q8-12h, po, iv), sucralfate to help heal gastric ulceration (250-500 mg/cat q8-12h po), and centrally acting anti-emetics to help block the effects of uraemic toxins on the chemoreceptor trigger zone (e.g. metoclopramide 0.2-0.5 mg/kg q6-8h po, or 1-2 mg/kg q24h as a constant iv infusion).

There are a number of different ways of encouraging cats to eat. These include the use of warmed or aromatic foods, and any intervention that improves the cat's sense of well being. Unfortunately, the use of chemical appetite stimulants is not without risk as diazepam can cause fatal hepatic necrosis (Center et al 1996) and cyproheptadine has been associated with haemolytic anaemia (personal observation). While anabolic steroids (e.g. nandrolone - see above) may appear to help in some case, few clinicians use them routinely. Where cats fail to maintain an adequate calorie (and/or fluid) intake, some clinicians will consider the long-term use of nasogastric or PEG tubes.

Evidence to support clinical benefit *Good*
Evidence to support role in preventing progression of CRF *None*

5.6 Systemic hypertension, antihypertensive drugs, and ACE inhibitors in particular

While the relationship between hypertension as a cause versus an effect of CRF remains poorly defined, it is essential that all cats with CRF be assessed for its presence. This is because hypertension is found commonly in cats with CRF (occurring in up to 60-65% of cases) and the presence of untreated hypertension may lead to exacerbation of the CRF (Brown et al 2000; Elliott et al 2001; Henik 1997; Kobayaski et al 1990; Littman 1994; Ross 1992). In a recent survey of our own CRF cases 14/26 (56%) were found to be hypertensive (systolic blood pressure > 175 mmHg (Brown et al 2000; Elliott et al 2001; Henik 1997; Sparkes et al 1999). Six cases were diagnosed at the time of initial presentation, and a further eight developed hypertension within five years of being diagnosed with CRF. Our study, plus a number of others, noted that there is no correlation between the degree of azotaemia and the presence or severity of systemic hypertension (Elliott et al 2001; Kobayaski et al 1990).

While the exact aetiology of hypertension in CRF remains unclear a number of factors appear to be involved (Henik 1997; Kobayashi et al 1990; Ross 1992): Diseased kidneys may be unable to efficiently excrete sodium and water (resulting in extracellular expansion), while activation of the Renin-Angiotensin-Aldosterone system (RAAS) leads to the production of Angiotensin II (which produces vasoconstriction) and aldosterone (which promotes sodium retention). Also, diseased kidneys may be unable to produce adequate amounts of vasodilator substances (e.g. prostaglandins and components of the kallilrein-kinin system), and autonomic dysfunction may result in increased circulating levels of catecholamines and an increased vascular responsiveness. While different types of renal disease may produce hypertension by different mechanisms, the presence of hypertension results in continually high glomerular filtration pressures that may worsen existing renal disease and contribute to further hypertensive injury and disease progression (Kobrin and Aradye 1997).

The most common changes consistent with persistent hypertension occur in the kidneys, eyes, heart and brain (Elliott et al 2001; Henik 1997). Unfortunately, hypertension is usually only suspected very late in the course of disease, once end-organ damage has already occurred. This is typically seen as exacerbation of renal failure, intraocular haemorrhage and/or blindness, hypertrophic cardiomyopathy, and/or cerebral vascular accidents. In our current series ocular signs were present

in 38%, and cardiac changes in 29% of the cases. Of the hypertensive cats, 71% had ocular evidence of hypertensive damage. Findings included anterior chamber, vitreal or retinal haemorrhage, retinal oedema or detachment, arterial tortuosity, alternating constriction and dilation of retinal primary venules, and/or glaucoma.

Various indirect methods exist for the measurement of blood pressure. However, in cats, the Doppler method is believed to be most accurate, as oscillometric methods tend to underestimate blood pressure (Bartges et al 1996; Brown et al 2000). The only problem with this technique is that it is difficult to get an accurate measurement of the diastolic pressure.

Although treatment of feline systemic hypertension has largely been extrapolated from human medicine, a number of studies have been carried out on cats. A number of treatment regimes have been suggested, including the use of a low salt diet, calcium channel blockers (CCBs) (e.g. amlodipine besylate; 0.625-1.25 mg/cat po q24h), and/or angiotensin converting enzyme (ACE) inhibitors (e.g. benazepril; 0.25-0.5 mg/kg po q24h). Also, where possible, any underlying conditions should be treated. While other therapies have been suggested, including the use of beta adrenergic receptor antagonists (e.g. propranolol), alpha adrenergic receptor antagonists (e.g. prazosin), arteriolar vasodilators (e.g. hydralazine), or diuretics (e.g. frusemide), they tend to be less reliable and/or effective (Bartges et al 1996).

Many people recommend *calcium channel blockers* (CCBs) (and amlodipine besylate in particular) as the single agent of choice for the treatment of systemic hypertension in cats (Bartges et al 1996; Elliott et al 2001, Henik 1997). CCBs may be of particular benefit in cats with CRF as they decrease systemic hypertension, dilate glomerular afferent arterioles, attenuate mitogenic effects of various growth factors, and attenuate mesangial entrapment of macromolecules (Epstein 1992). However, because of preferential afferent arteriolar dilation, elevated systemic blood pressure may be transmitted to the glomerulus, resulting in glomerular hypertension (Tolins and Raji 1991).

ACE inhibitors are now becoming a first line therapy for the treatment of systemic hypertension in humans with CRF (Jafar et al 2001; Maschio et al 1996). The positive effects of using ACE inhibitors to treat hypertension in CRF arise because, by inhibiting the conversion of angiotensin I to angiotensin II, ACE inhibitors decrease aldosterone secretion, decrease plasma and urine angiotensin II, increase urine concentration of protaglandin E and bradykinin, reduce intra-glomerular capillary blood pressure (due to efferent arteriolar dilation), and reduce glomerular hyperfiltration and proteinuria (Allen et al 1987; Tolins and Raji 1991). However, ACE inhibitors may also lead to reduced renal perfusion and so cause tubular necrosis, resulting in progression of the renal failure (Amadio et al 1990). This may be more of a significant problem for those ACE inhibitors that are exclusively excreted though the kidney and their doses need to be adjusted in cases of CRF (Allen et al 1987). One advantage of benazipril is that most of its excretion is through the liver.

In cats, the beneficial effects of ACE inhibitors (and benazepril in particular), have been shown in a number of studies of experimental and naturally occurring CRF. Significant reductions in systemic blood pressure, glomerular capillary pressure, angiotensin II, aldosterone, and proteinuria have been documented (Brown et al 2001; Watanabe et al 1999). Preliminary results from the BENRIC study (Novartis, personal communication 2001) support these findings, with the most significant effects being seen in proteinuric patients.

Is it better to treat cats with CRF with CCBs or ACE inhibitors?

There is still debate as to whether it is preferable to use an ACE inhibitor or amlodipine in the treatment of feline CRF. Many clinicians show a preference for amlodipine, partly because it tends to give more predictable results (Brown and Henik 2000), and also because it is usually more effective in reducing very severe hypertension. (That said, in our recent series of hypertensive cats, benazepril induced an average reduction of systolic blood pressure of 56 mmHg, see Table 4). However, there is now growing evidence to support the use of ACE inhibitors, not only in hypertensive cats, but more widely in normotensive individuals with CRF. This is because studies in human patients have suggested that ACE inhibitors are more effective at reducing the progression of renal failure, even in cases where no systemic hypertension is present (Jafar et al 2001). ACE inhibitors have also been shown to be more renoprotective than CCBs in dogs with experimental CRF (due to induced diabetes mellitus) (Brown et al 1993). While ACE inhibitors are most effective in the treatment of CRF associated with mild to severe proteinuria or diabetes mellitus (Maschio et al 1996), their beneficial effect in non-proteinuric cases has lead to the suggestion that they may have a positive effect

beyond decreasing blood pressure and reducing urinary protein loss (Jafar et al 2001). Unfortunately, in very severe and/or refractory cases neither CCB nor ACE inhibitors may be sufficient, and anecdotal evidence appears to support the combined use of these drugs.

Evidence to support clinical benefit	*Good*
Evidence to support role in preventing progression of CRF	*Poor*

5.8 Urinary tract infections

Urinary tract infections (UTIs) occur commonly in cats with CRF. In a number of studies 25-35% of cases were found to have a UTI at some point during their illness (Demetriou et al, 1997; Barber person communication 2001). Interestingly, 75% of the UTIs occurred in female cats, and many of these cats had recurrent episodes of infection (Barber, personal communication, 2001). Unfortunately, while the presence of a UTI rarely results in specific clinical signs it is highly likely to exacerbate the renal damage. It is therefore essential that cats with CFR be regularly assessed for the presence of a UTI. This can only be done by performing urinalysis *and* bacterial culture, so urine samples need to be collected by cystocentesis.

Evidence to support clinical benefit	*Good*
Evidence to support role in preventing progression of CRF	*None*

5.9 Long-term monitoring

Long-term monitoring is essential. Each examination should be as extensive as the initial examination (see above), and it should be repeated every one to six months, depending on the severity and extent of the clinical signs.

Table 1. Potential aetiologies of feline chronic renal failure

Chronic tubulointerstitial nephritis
Glomerulonephritis
Pyelonephritis
Polycystic renal disease - congenital or acquired
Amyloidisis - familial or acquired
Nephrotoxins - e.g. ethylene glycol, antibiotics
Hypercalcaemia
Hydronephrosis
Renal lymphoma
Eventual result of untreated pre-renal or post-renal failure

Table 2. Common clinical signs in 412 cases of CRF [a]

Clinical sign	%
Dehydration	62
Anorexia	62
Lethargy / depression	47
Weight loss	46
Polydipsia / polyuria	38
Vomiting	29
Large kidneys (1 or both)	25[b]
Small kidneys (1 or both)	19
Pale mucous membranes	10
Oral ulceration / discomfort	10
Also Retinal detachment Poor coat Thin Halitosis Diarrhoea or constipation	

[a] Based on four studies (Lulich et al 1992; Krawiec and Gelberg 1989; DiBartola et al 1987; Elliott and Barber 1998). [b] Based on 337 cats from three studies (Lulich et al 1992; Krawiec and Gelberg 1989; DiBartola et al 1987).

Table 3. Common clinicopathological findings in 286 cases of CRF [a]

Finding	%
↑ plasma urea	98
↑ plasma creatinine	98
↑ plasma PTH	84[b]
Urine specific gravity < 1.030	75[c]
↑ plasma phosphate	63
↓ plasma TCO_2	55
Anaemia	37
↓ plasma calcitriol	36[b]
↓ plasma ionised calcium	25[b]
↓ plasma potassium	21
↑ plasma cholesterol	72
Urine protein:creatinine > 1.0	< 10[c]
Also ↑ plasma amylase ↓ Lymphocytes ↑ plasma glucose ↑ White blood cells ↑ plasma ionised calcium	

[a] Based on four studies (Barber and Elliott 1998; Lulich et al 1992; DiBartola et al 1987; Elliott and Barber 1998). [b] Based on 80 cats (Elliott and Barber 1998). [c] Based on 52 cats (Elliott and Barber 1998).

Table 4.

Treatment	Benazepril (n=9)	Amlodipine (n=3)
Ave. systolic BP before Tx (mmHg)	210	244
Ave. systolic BP after Tx (mmHg)	154	154
Ave. reduction in BP (mmHg)	56	90

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Diabetes Mellitus in Cats

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Incidence and pathogenesis:
Diabetes mellitus (DM) is the second most common endocrinopathy in cats (following hyperthyroidism). It is caused by a multifactorial group of disorders that result in an absolute or relative lack of insulin. Its incidence in cats is approximately 1 in 200 veterinary patients in the UK (PetProtect), and is thought to be increasing, probably resulting from an increased incidence of obesity and an increased percentage of older cats. While it can occur in any age, sex or breed of cat, it is seen most frequently in older obese neutered male cats. In Great Britain, Australia and New Zealand Burmese cats appear to be predisposed.

Classification of DM in cats is best made by cause, rather than whether or not they require exogenous insulin.

Type 1 - juvenile onset DM due to an **immune-mediated attack** on pancreatic islet beta cells. This appears to be very rare in cats.

Type 2 - results from impaired insulin secretion, peripheral resistance to the action of insulin, and increased hepatic glucose production. Many cats with DM fall into this group. This often results from the **accumulation of islet-specific amyloid polypeptide** (IAPP) which occurs in aggregates around pancreatic islets. While IAPP is co-secreted and accumulates in normal cats as they age, it accumulates more extensively in cats with DM. The accumulation of IAPP acts as a barrier against insulin diffusion and antagonizes insulin action. While these cats may initially be non-insulin dependent (NIDDM), progressive loss of islet cells usually results in a need for exogenous insulin (IDDM). **Obesity** is a significant risk factor for Type II DM because it causes a reversible peripheral insulin resistance.

Type 3 - also known as secondary DM can result from:

- Beta cell dysfunction e.g. due to **pancreatitis**. This may be more common than previously thought as >50% of diabetic cats have evidence of past or current pancreatitis at necropsy. However, this does not mean that 50% of feline DM is caused by pancreatitis. Rather, it means that while pancreatitis can cause DM, unstable DM can also cause pancreatitis (due to the toxic effect of chronic hyperglyaemia). It can be very difficult to determine which came first. In cats, pancreatitis often occurs concurrently with inflammation of the liver and intestines, so called Triaditis. Where this occurs the presence of these other conditions can further complicate the clinical presentation, diagnosis and treatment of the DM. Chronic pancreatitis can eventually lead to significant loss of pancreatic function which can result in the development of DM and/or exocrine pancreatic insufficient (EPI).
- Underlying or concurrent disease e.g. **acromegaly, hyperadrenocortisim** and even **hyperthyroidism** can all result in insulin resistance.
- **Drug administration** e.g. corticosteroids, progestogens (megestrol acetate).

60-70% of cats with DM require exogenous insulin, at least temporarily.
15-25% of cats with DM may loose the need for exogenous insulin, most typically within 1-3 months of first becoming diabetic. These **transient diabetics** may result from:

- Correction of **'glucose toxicity'** - prolonged hyperglycemia causes impaired insulin secretion by islet beta cells and increased peripheral resistance. Exogenous insulin administration and reduction of hyperglycemia can result in resolution of this toxicity, at least initially.
- Reduction of obesity.
- Resolution of pancreatitis.
- Treatment of concurrent or underlying disease.
- Removal of diabetogenic drugs.

Clinical signs:
The clinical signs of DM in cats can be very subtle, and affected cats are often not presented for investigation until they become systemically ill. **The most consistent signs are polyuria, polydipsia, and polyphagia.** Because of the polyphagia some owners report their cats had **initial weight gain, followed by weight loss.** These early signs often go unnoticed by the owners, possibly because of free choice feeding and outdoor lifestyles. Urinary tract infections are common, so affected cats may present with signs of cystitis and/or renal failure. The coat of many diabetics becomes ill kept and a pot-bellied appearance may result from hepatomegaly. Hind limb weakness and a plantigrade stance (due to diabetic neuropathy) are seen quite frequently, but cataracts occur rarely. Cats are frequently presented only when they become systemically ill with signs of anorexia, vomiting and/or diarrhea, jaundice and depression. Cases of DM that result from chronic pancreatitis may have a history that includes episodes of depression, anorexia, vomiting, diarrhea, and/or abdominal pain. In addition, since DM is most likely to occur once most of the pancreatic mass has been destroyed it may also be accompanied by signs of EPI (i.e. a voracious appetite and large quantities of voluminous fatty feces).

Diagnosis:
Diagnosis is based on documenting persistent fasting hyperglycemia (> 11 mmol/l) **and glucosuria in a cat with appropriate clinical signs (polyuria, polydipsia and polyphagia).** However, since stress-induced hyperglycaemia (up to ~20 mmol/l) can result in glucose levels above the renal threshold (12-14 mmol/l) it can readily result in glucosuria. Because of this a single documentation of these findings is not diagnostic of DM. Allowing the cat to settle down and then re-testing it after a few hours may help to determine whether or not the hyperglycaemia is stress-induced. Alternately, the owner can be asked to test the cat's urine for the presence of glucose when it is at home.

While ketoacidosis confirms the presence of diabetic ketoacidosis (DKA), it is much rarer in cats than dogs. Assessing serum fructosamine concentrations can be useful as they give an indication of how raised the blood glucose levels have been during the preceding 2-3 weeks. However, some care is required as they can be raised where there has been prolonged stress hyperglycaemia; e.g. when a cat has been hospitalised. On the other hand, this condition may occasionally require insulin therapy to return the cat to a euglycemic state during or following resolution of the primary condition.

Many cats with DM have mild to moderate increases in serum concentrations of cholesterol and liver enzymes. More severe changes, bilirubinaemia, acidaemia, uraemia, and electrolyte disorders usually indicate the presence of complicated DM or DKA.

Treatment:
Treatment consists of various combinations of weight loss, dietary modification, insulin administration, and/or oral hypoglycaemic agents. While the signs of DM in obese cats may resolve with dietary modification most cats need at least temporary medical intervention. Insulin is required for most diabetics, at least initially. Oral hypoglycaemic agents may be successfully used in some uncomplicated diabetics or once glucose toxicity has resolved following insulin therapy.

1. **Dietary modification -**
Cat with diabetes may have difficulty assimilating the carbohydrates present in most commercial cat foods. **Recent studies have shown that diabetic cats have better glycaemic control and are more likely to be able to discontinue exogenous insulin when they are fed a diet that is high in protein and low in carbohydrate.** This is in contrast to the previously recommended high fibre diets. High fiber diets can help slow glucose absorption, but a low carbohydrate, high protein diet appears to provide superior control. Where any carbohydrate are present in the diet they should be in the form of complex carbohydrates not simple sugars. Most dry foods contain considerable carbohydrates, whereas many canned foods contain relatively little. On the other hand, each food is different, so use caution in selecting the appropriate diet.

The profile of recommended diet varies with the body condition of the cat (see below) and, in some cases, may be affected by concurrent illness. e.g. if chronic renal failure is also present, a diet with lower protein content may be considered.

Non-obese diabetic cats: For the reasons described above these cats **should be fed a diet that is high in protein and low in carbohydrate.** See Table 1 for profiles of diets for diabetic cats and compare their

protein and carbohydrate values. A very good recommendation is *Nestlé Purina DM.*

Obese diabetic cats will benefit from weight loss. However, this should be done very gradually, restricting calorie intake to no more than 75% of maintenance requirements and monitoring for changes in insulin requirement. It is best to feed a diet with restricted calories rather than simply decreasing the amount of the regular diet. This is because decreasing the amount of food fed also decreases the cat's intake of protein and vitamins. While this may only result in begging and stealing food it can, in extreme cases, result in significant deficiencies. A weight loss diet for a diabetic cat should still have a high amount of protein, which helps to prevent hepatic lipidosis, and/or it should be supplemented with carnitine. In order to induce weight loss some of these diets contain an increased amount of fibre. Fibre provides a satiety factor, helping cats feel full with less calorie intake, as well as helping slow glucose absorption. While this works well in some cats, others find the high levels of fibre poorly palatable. The increase in dietary fibre can also lead to management considerations in cats that use litter boxes as it increases the quantity of faeces produced. (Table 1 also contains profiles of feline diets designed to incur weight loss).

In summary, obese diabetic cats may **benefit from being fed a high protein, low calorie, and possibly, high fiber diet to help them lose weight** e.g. *Nestlé Purina MD or OM.*

All diabetic cats benefit from being fed a well-balanced diet on a regular, consistent, feeding schedule. Cats on once daily insulin are usually fed just before their morning insulin, then again in the early evening. Cats on twice daily insulin are usually fed just before both insulin injections. Free-choice feeding can be beneficial and suits many diabetic cats. However, when feeding cats in this manner it is important to monitor the amount of food eaten on a daily basis.

2. Insulin -

There are a number of different types of insulin, and the choice is often based on personal preference. **Most cats with uncomplicated DM respond well to once or twice daily subcutaneous administration of lente or protamine zinc insulin (PZI) insulin.** The duration of action of the different insulin preparations varies between cats so it should be determined for each individual.

Typical actions are:

- **Lente** - peak 2-10h, duration of action 6-16h; ~all cats need twice daily injections.
- Caninsulin™ has a duration of action similar to lente, but should be started at a lower starting dose as it is more potent.
- **PZI** - peak effect at 3-12 h, duration of action 6-24h; most cats need twice daily injections, but 20-30% may cope with once daily.

The source of the insulin does not appear to matter too much in cats as anti-insulin antibodies do not cause many problems.

When starting to treat a newly diagnosed diabetic it is recommended to give ~0.25 IU insulin/kg/per injection (to a maximum of 3 IU/cat), and then adjust as necessary, usually by 0.5-1.0 IU per dose. As the dose may be small consider using 0.3ml syringes to assist in accurate dosing. Do not dilute insulin in order to achieve accurate dosing, as this often damages the insulin and results in unpredictable results. The aim of therapy is to prevent the clinical signs of DM and, if possible, maintain blood glucose concentration between 5.5-14 mmol/l.

When starting treatment it is usually best to start at a low dose of insulin and send the cat home for a week. This is because **it takes 3-4 days for glucose homeostasis to adjust after starting or altering insulin doses**. Any changes in insulin dose should therefore be based of recurring effects, not a single urine (or blood) glucose determination, and increases should not be made more frequently than once per week. During this time the owners can monitor urine glucose and ketone levels at home (ideally glucose will be negative/trace and ketones will be negative).

After a week the cat can be hospitalized for a 12-24 hour **blood glucose curve** (BGC). It is often recommended that BGCs be performed every 1-2 weeks until the diabetes is stable. After this time they need be performed less frequently, and the insulin dosage can be adjusted in response to changes clinical signs and serum fructosamine concentrations.

A BGC is performed by giving the cat its usual breakfast and dose of insulin, then determining the blood glucose level every 1-2h during a 12-24h period. If the level of the blood glucose at its nadir (lowest

point) is not adequate then increase the insulin dose. If the duration of action is too short then consider changing to PZI insulin once or twice daily. After recommending the change the cat should be sent home on the new regime and the whole process repeated after a further seven days.

Unfortunately, the use of BGCs can be very limited in cats that develop stress hyperglycaemia when hospitalized. To reduce the risk of this occurring it is best to use peripheral ear veins rather than jugular or cephalic sampling. *(This is the best technique to use when taking either a single blood glucose value or when performing a blood glucose curve. a] The edge of the ear is smeared with Vaseline to prevent the blood running into the hair coat. b] The ear is then held firmly and gently between four fingers, which act in pairs to raise the vein and prevent its movement. c] The vein can then be pieced using either a fine hypodermic needle or a lancet. d] Holding the vein still for a few seconds will allow a bleb of blood to form. e] This can then be transferred to the glucometer test strip or, where appropriate, the glucometer can be applied directly to it).* It is meaningless to perform a BGC in a cat with stress hyperglycaemia. For these cats it is often possible to train their owners to check their cat's blood glucose level at home, and even to perform BGCs.

At all times, but especially after altering the insulin dosage, the owners should be warned to look for signs of hypoglycaemia (a sudden desire to hide, excessive quietness, weakness, lethargy, shaking, ataxia, collapse and coma). If these signs occur the cat's gums should be rubbed with sugar water, jam or honey, and immediate veterinary attention sort.

Reasons for apparent insulin resistance include:
Spurious insulin resistance -

- Ineffective insulin (out of date, incomplete mixing, poor storage [insulin will bind to the rubber stopper of the dispensing bottle if it is stored upside down or on its side, so causing loss of activity])
- Poor injection technique
- Incorrect dosage because of syringe-type insulin-type mismatch (for this reason it is important to always use the correctly paired insulin and syringe)
- Insulin overdose (leading to insulin-induced hyperglycaemia [the Somogyi over-swing occurs when hypoglycaemia induces counter-regulatory hormones such as adrenaline and glucagon to induce hyperglycaemia])
- Out of date urine test strips

True insulin resistance -

- Recent weight gain
- Pancreatitis
- Failure of insulin absorption
- Infection (most frequently urinary tract infection or gingivitis)
- Administration of diabetogenic drugs
- Hyperthyroidism
- Acromegaly
- Hyperadrenocorticism
- Renal or hepatic insufficiency
- Anti-insulin antibodies (very rare in cats)
- Presence of certain types of tumour

3. Oral hypoglycaemic agents -

These can act to increase insulin secretion, decrease peripheral insulin resistance, and/or decrease the absorption of glucose from the intestinal tract. They may successfully control some non-ketotic, uncomplicated diabetics, either temporarily or longer term, particularly when given in conjunction with dietary modification. Unfortunately, because they often act by stimulating insulin secretion, they can ultimately cause pancreatic islet cell exhaustion, so causing a non-insulin dependent diabetic (NIDDM) to become insulin dependent (IDDM).

There are several different types of drugs that have been shown to be at least somewhat effective in cats:

- **Sulfonylureas e.g. Glipizide** (0.25-1.0 mg/kg PO q8-12h, adjust dose as needed); side effects include vomiting, anorexia, and hepatopathy. Periodic checks for serum biochemistry and hematology are recommended. It may take a few weeks of medicating to see the full

effect of the drug.

- **Alpha-glucosidase inhibitors e.g. Ararbose** (12.5-25 mg/cat with meals); side effects include flatulence, soft faeces and diarrhoea.
- **Transition metals e.g. Vanadium** (0.2 mg/kg/day in food); side effects include anorexia, vomiting, diarrhea and renal disease; **Chromium** (200 ug/cat/day PO); side effects unknown.

Prognosis:

The prognosis of any cat with DM is very unpredictable. It depends on the owners' commitment, the presence of concurrent and interacting disease, and the ease of glycaemic control. However, long-term it is generally guarded and when chronic pancreatitis is also present it can be particularly difficult to control.

Prevention:

The risk of developing DM can be reduced by not allowing cats to become obese, and by not giving long courses of diabetigenic drugs.

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		PVD DM wet	PVD OM wet	PVD OM dry	Hill's m/d wet	Hill's m/d dry	Hill's r/d wet	Hill's r/d dry	Hill's w/d wet	Hill's w/d dry	Royal Canin-Waltham Diabetic Feline DP 46 dry
TYPICAL ANALYSIS	**Unit**	gr/1000 Kcal.									
Protein	%	12.35	11.40	11.07	13.09	12.30	11.49	11.74	10.94	11.45	13.77
Fat	%	5.34	3.44	2.44	4.80	5.20	2.84	2.81	4.48	2.71	3.59
Fiber	%	0.88	1.61	2.28	1.50	1.30	5.54	4.68	2.81	2.15	1.68
Ash	%	2.54	1.83	2.44	NA	NA	1.89	1.77	1.77	1.69	1.95
Carbohydrates	%	1.93	8.17	11.56	3.90	3.70	10.14	10.10	6.56	10.62	10.90
Declared M.E.	Kcal/Kg	1142	930	3070	1001	3960	740	2990	960	3250	3340

		PVD DM wet	PVD OM wet	PVD OM dry	Hill's m/d wet	Hill's m/d dry	Hill's r/d wet	Hill's r/d dry	Hill's w/d wet	Hill's w/d dry	Royal Canin-Waltham Diabetic Feline DP 46 dry
TYPICAL ANALYSIS	**Unit**	DRY MATTER									
Protein	%	**53.61**	43.09	37.16	52.82	52.0	36.02	37.74	41.18	40.00	49.46
Fat	%	23.19	13.01	8.20	19.35	22.0	8.90	9.03	16.86	9.46	12.90
Fiber	%	3.8	6.10	7.65	6.05	5.3	17.37	15.05	10.59	7.53	6.02
Ash	%	11.03	6.91	8.20	NA	NA	5.93	5.70	6.67	5.91	6.99
Carbohydrates	%	**8.37**	30.89	38.80	15.73	15.5	31.78	32.47	24.71	37.10	39.14
Declared M.E.	Kcal/Kg	4342	3780	3355	4036	4213	3136	3215	3765	3495	3591
Hill's data as published in "The Key..." Oct 2002											

Table 1. Principle diets suitable for the management of feline diabetes mellitus in Europe.
ME = metabolizable energy, kg - kilogram, DM = dry matter basis, NA = not available
It is recommended that non-obese cats with diabetes mellitus should be fed a diet that is high in protein and low in carbohydrate, without excessive dietary fat. From the table we see that of the diets with high protein levels only Nestlé Purina DM is also low in carbohydrate.

Cognitive Dysfunction Syndrome

Danièlle Gunn-Moore
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Case:
Sally - 16 year old FN DSH

History
Indoor/outdoor cat. Over the last 2 years she has 'aged' considerably, lost some weight, and completely stopped grooming. She has an indoor litter box but is now not using it all the time since she is also urinating around the house. In addition, she has now started crying very loudly at night, waking her owners. Her appetite has always been picky, and remains unchanged.

Physical examination
Sally appeared bright and alert, if rather thin and ill-kept. Clinical examination revealed a heart rate and pulse of 190 beats per minute, with a very occasional gallop or a grade II/VI systolic murmur, loudest over the sternum. Respiration rate was 40 breaths per minute. Slight thyroid gland enlargement was palpable on the left hand side. Chest and abdominal palpation were unremarkable, other than noting that she was very thin. She was non-febrile.

1. *Give the problem list, and list the differential diagnoses for the major clinical problem(s)*

Inappropriate urination:
- FLUTD
- Behavioural problem
- Resulting from polyuria/polydipsia
- Neuromuscular/orthopaedic disease

Tachycardia, occasional gallop and a grade II/VI systolic murmur:
- Primary cardiac disease
- Secondary cardiac disease, e.g. hyperthyroidism (consider slight thyroid gland enlargement), CRF, DM.

Altered behaviour and night-crying:
- Hypertension - primary or secondary (hyperthyroidism, CRF, HCM, DM)
- Degenerative CNS disease e.g. cognitive dysfunction syndrome, deafness
- Neoplasia (lymphoma, meningiooma, etc.)
- Infectious disease (FIV, FeLV, toxoplasmosis, FIP, Borna disease)
- Metabolic disease - hepatic encephalopathy, CRF
- Pain
- Inflammatory disease

2. *Detail your diagnostic plan, and explain your approach:*
- Examine retinas and check systemic blood pressure.
- Full neurological examination.
- Haematology, serum biochemistry, serum thyroxine, urinalysis and culture.
- ECG, echocardiography, chest radiography.
- MRI/CT

COGNITIVE DYSFUNCTION SYNDROME:

With improvements in nutrition and veterinary medicine the life expectancy of pet cats and dogs is increasing. Accompanying this growing geriatric population there are an increasing number of pets with signs of apparent senility. It is generally accepted that cognitive and motor performance deteriorates with age, and experiments with cats have indicated that this deterioration usually occurs between 10-20 years of age. Recent studies suggest that 28% of pet cats aged 11-14 years develop at least one geriatric-onset behaviour problem, and this increases to over 50% for cats of 15 years of age or older.

Cognitive dysfunction syndrome (CDS) is a neurodegenerative disease resulting in geriatric-onset behavioural problems. The clinical signs can include disorientation, altered interaction with the family, changes in sleep-wake cycles, changes in activity such as wandering and/or pacing, inappropriate urination/defecation, and/or inappropriate vocalisation. Diagnosis is made on the basis of several altered cognitive signs. The cause of the syndrome in cats and dogs is still unknown. However, recent work points to the involvement of disease processes similar to those seen in humans suffering from neurodegenerative disorders, such as Alzheimer's disease (AD).

Histopathologically, there are two major hallmarks of AD; senile plaques and neurofibillary tangles. Senile plaques (SP) are formed by the extracellular accumulation of the · -amyloid (A·) protein. Neurofibillary tangles (NFT) are formed by the initially intracellular accumulation of the abnormally hyperphosphorylated form of the microtubule protein tau (in its unphosphorylated form tau is involved in forming the cytoskeleton of neurons). While there are a number of theories suggesting how these deposits may be associated with neurological degeneration, it is currently believed that the accumulation of A· into SP may initiate inflammatory change and neurotoxicity which then results in tau hyperphosphoroylation, NFT formation and neurological dysfunction. In addition to A· accumulation as SP it also accumulates around the meninges and blood vessels (ultimately resulting in cerebral amyloid angiopathy [CAA]). However, these changes are not pathognomonic of AD as SP and CAA are also seen in the brains of senescent humans who did not show clinical signs of AD, and the brains of many aged mammals. In addition, hyperphosphorylated tau is also present during postnatal development and arises in response to degenerative events such as ischemia or seizures.

Using sensitive immunohistochemical techniques it has been possible to show that the pattern of canine A· accumulation parallels that seen in humans, being age-related, with plaques developing in several cortical and subcortical brain regions. In Beagles, the earliest and most consistent site of A· deposition is the prefrontal cortex (at about 9-10 years of age), with the development of SP in the parietal and occipital lobes at a later age. Interestingly, deposition within the entorhinal cortex is not consistently observed until 14 years of age, except in a subset of dogs that show signs of early-onset cognitive impairment.

Studies have shown a direct correlation between the extent of A· deposition and the extent of cognitive dysfunction in dogs, with the regions of the brain affected correlating with certain types of learning and memory deficits. Intriguingly, while all dogs naturally accumulate diffuse SP and CAA with age, some breeds appear to develop them at an earlier age than others. In agreement with this, age-related cognitive dysfunction has been shown to vary between different breeds (and sources) of dogs.

The understanding of CDS in cats is even less advanced than in dogs. Immunohistochemical techniques have shown that while A· is constitutively expressed within cat brains, the intensity of its accumulation within neurons and blood vessels appears to be age-dependent, as is the development of diffuse SP within the deep cortical layers. To date, the investigation of only 25 cats has been published; 23 of which were over 12 years of age. These studies appear to show that older cats are more likely to develop SP (only the 14 oldest cats were found to have SP). Our own study supports this finding: SP were seen in seven of nine cats of over 10 years of age, but none of 10 younger cats. Interestingly, the SP appear to be even more diffuse than those seen in dogs, and quite unlike the well developed and circumscribed SP that are typical of humans. While NFT have not been seen in cat brains, immunostaining for hyperphosphorylated tau has been demonstrated, occurring concurrently within the neurons of some of the cats showing SP development, and providing evidence of possible pre-tangle formation in 4 older cats.

While the relationship between seeing SP and/or positive staining for hyperphosphorylated tau and behavioural or neurological dysfunction has not yet been well explored in cats, preliminary studies appear to indicate that there may be a correlation. For 17 of the cats previously assessed for SP the presence or absence of behavioural change was known: eight had behavioural changes consistent with CDS; seven of these were found to positive, as compared to only three of the nine cats without behavioural changes. For seven of the cats assessed for hyperphosphorylated tau the presence or absence of behavioural change was known: five of these had behavioural changes; two of which were positive for tau, compared to one of two cats without behavioural changes. Interestingly, amongst five cats with well documented CDS the severity of the behavioural changes did not appear to correlate particularly well with the extent of the SP formation.

Hence, while there are many similarities between CDS and AD, CDS should not be considered as a model for AD as there are a number of subtle differences between the two diseases. For example, as yet, NFT have not been detected in cats or dogs, possibly because they have isoforms of tau that cannot form PHF. Alternatively, it may be that these species do not usually live long enough to develop NFT. Further investigations are needed to confirm, for example, whether or not these changes only relate to progressive age, and/or to the presence of particular disease processes or disorders. In addition, the extent of the changes needs to be correlated with the clinical signs of CDS, and it remains to be seen whether or not particular breeds of cat may be predisposed.

Treatment options of CDS:

As yet, there is no published information relating to the successful treatment of cats with CDS. It may be possible to consider potential treatment options by extrapolation from work with humans with AD and/or dogs with CDS. There are a growing number of possible therapeutic options for AD; these include the use of selegiline (to manipulate the monoaminergic system), various cholinesterase inhibitors (to increase the availability of ACh at the neuronal synapses), or antioxidants (e.g. Vitamin E) and non-steroidal anti-inflammatory drugs (e.g. ibuprofen) to reduce neuronal damage.

There have been a very small number of studies in dogs. These appear to suggest that high doses of mixed antioxidants and selegiline (l-deprenyl) may have beneficial effects. A four year study into the use of dietary antioxidants (vitamin E and complex antioxidants) revealed significant improvements in learning and memory. In a separate study selegiline has been shown to improve sleep/wake cycles and interaction with the family after it has been given for longer than a month (0.5-1.0 mg/kg po a24h). Interestingly, while selegiline appeared to provide symptomatic relief, it had little or no effect on disease progression.

Management:

Since there are, as yet, no proven medical options for cats with CDS, it is necessary to advice clients how best they can manage these cases. Affected cats often become stressed and cope very poorly with change: whether in their environment, their daily routine, their diet, or the members of the houshold with which they live. The cat's response to this stress is usually to stop eating, hide, and/or alter its toileting habits. Where possible, changes should be kept to a minimum. However, when a change cannot be avoided, it is very important that it is planned carefully and made slowly, with much reassurance. Some cats become progressively more senile. These cats may benefit from having their area of access reduced, while still containing all necessary facilities. This small area can then be kept safe and constant.

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Revaccination Intervals and Duration of Serological Response to Modified-Live Vaccine

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1. Fundamental Question: How long is it safe to wait to vaccinate the cat before you on the table?

2. Multiple ways to answer question...but what data can I base my answer on?

3. How can the serological data presented help in answering the question?

Table 1: Percent "Responders" by Antigen Over Time

	Months Since Last Vaccination							
Viral Antigen	Overall (n = 272)	12-18 *(n=108)*	19-24 *(n=49)*	25-30 *(n=25)*	31-36 *(n=19)*	37-42 *(n=25)*	43-48 *(n=13)*	>48 *(n=33)*
FPV	96.7%	96.3%	100%	96%	100%	96%	92.3%	93.9%
FCV	97.8%	99.1%	100%	96%	100%	84%	100%	100%
FHV	88.2%	84.3%	95.9%	92%	94.7%	80%	100%	84.8%

For more detailed information and data, please refer to:
Mouzin DE, Lorenzen MJ, Haworth JD, et al. Duration of serologic response to three viral antigens in cats. *J Am Vet Med Assoc.* January 1, 2004;224L61-66

Duration of serologic response to three viral antigens in cats

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Objective—To determine whether vaccinated cats either remained seropositive or responded serologically to revaccination against 3 key viral antigens after extended periods since their last vaccination.

Design—Serologic survey.

Animals—272 healthy client-owned cats.

Procedure—Cats were ≥ 2 years old and vaccinated for feline panleukopenia virus (FPV), feline calicivirus (FCV), and feline herpesvirus (FHV). On day 0, cats were revaccinated with a vaccine from the same line of vaccines as they had historically received. Antibody titers were measured in sera collected on day 0 (prevaccination titer) and 5 to 7 days later (postvaccination titer). Cats were considered to have responded serologically if they had a day-0 hemagglutination inhibition titer to FPV ≥ 1:40, serum neutralization (SN) titer to FCV ≥ 1:32, SN titer to FHV ≥ 1:16, or ≥ 4-fold increase in antibody titer after revaccination.

Results—The percentage of cats that had titers at or above the threshold values or responded to revaccination with a ≥ 4-fold increase in titer was 96.7% for FPV, 97.8% for FCV, and 88.2% for FHV.

Conclusions and Clinical Relevance—In most cats, vaccination induced a response that lasted up to and beyond 48 months for all 3 antigens. Although not equivalent to challenge-of-immunity studies as a demonstration of efficacy, results suggest that revaccination with the vaccine used in our study provides adequate protection even when given less frequently than the traditional 1-year interval. The study provides valuable information for clinicians to determine appropriate revaccination intervals. (*J Am Vet Med Assoc* 2004;224:61–66)

Veterinary vaccines approved by the USDA have historically been granted a 1-year revaccination recommendation, although maximum duration of immunity has not been established (rabies vaccines with approved multiyear revaccination intervals are exceptions). The annual revaccination interval has greatly reduced the prevalence of infectious diseases in dogs and cats. In addition, the annual revaccination visit has provided veterinarians and pet owners with a convenient time for a periodic physical examination and a review and discussion of the pet's health status. However, in recent years, the annual revaccination interval has been increasingly questioned as being somewhat arbitrary and based on convenience and limited scientific data. It has instead been proposed to base revaccination intervals on disease risk, determination of which antigens are core components of a sound immunization program, duration of immunity conferred by specific vaccines, and the risk of postvaccination reactions.

The emergence during the past decade of an epidemiologic link between vaccination and injection-site fibrosarcomas in cats[1,2] has been a factor in prompting recommendations for feline revaccination intervals > 1 year.[3-5] The reported prevalence of injection site sarcoma varies. In 1 study, prevalence was established at 158 cases in 434,638 cats, or 3.6 cases/10,000 cats.[6] In another study, prevalence was reported at 1.9 cases/10,000 cats.[2] More recently, epidemiologists who used a database of 31,671 cats established a prevalence of 0.63 sarcomas/10,000 cats.[7] In addition to fibrosarcomas, possible links to vaccine-associated autoimmune diseases in dogs and cats have been reported.[8,9]

For most feline and canine diseases, the optimum revaccination interval is based on postvaccination duration of immunity. The definitive method for establishing duration of immunity is a real-time challenge study. However, efficacy of veterinary vaccines is usually evaluated by detecting short-term protection against challenge several weeks after primary vaccination. The most notable exceptions are rabies vaccines for which 1- to 3-year duration of immunity in dogs or cats must be proven as a public health safeguard. Presently, regarding revaccination interval recommendations on product labeling, the USDA Center for Veterinary Biologics states that the role of sustained serologic titers in the prevention of disease has not been confirmed. The cost and difficulty of keeping animals in isolation for extended periods and concerns about the welfare of animals maintained at length under experimental conditions make it impractical to conduct multiyear, duration-of-immunity studies in a test population of sufficient size. In addition, certain factors inherent in the challenge-of-immunity model sometimes limit its relevance or practicality for proving efficacy. Susceptibility to some diseases can vary with the age of the animal (eg, older cats are more resistant than kittens to FeLV infection), and experimental isolation of animals creates an artificial environment that does not duplicate natural patterns of exposure and susceptibility. Thus, serologic response to vaccination has been proposed and used as a helpful alternative to real-time challenge studies in determining duration of immunity.[10-16] This approach is potentially valuable in diseases in which serologic data are indicative of protection.

The purpose of the study reported here was to

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determine duration of serologic response to the 3 viral pathogens most widely used for feline vaccination—feline panleukopenia virus (FPV), feline calicivirus (FCV), and feline herpesvirus (FHV).[5,14] In several studies, vaccine-induced serum antibody responses to each of these antigens have been correlated with resistance to infection or clinical disease.[12,14,15] Cats were also grouped into high- and low-risk categories to determine whether lifestyle and disease risk correlated with serologic response.

Materials and Methods

Cats—Cats were selected for the study after a thorough evaluation of their medical records; 272 client-owned cats of both sexes, either sexually intact or neutered, and of various ages, breeds, weights, lifestyles, and intervals since last vaccination were enrolled in the study. Cats were required to be clinically normal, have negative results of a day-0 test result for FeLV and FIV, be at least 2 years old, not vaccinated within the past 12 months, and with no documented medical history of disease due to FPV, FCV, FHV, or *Chlamydia psittaci* (*Chlamydophila felis*) infection. In addition, cats must have received a documented 2-dose primary vaccination series with a vaccine from the same line as the test vaccine[a] administered 2 to 7 weeks apart as a kitten and at least 1 revaccination dose of vaccine at an 8- to 16-month interval. Cats were excluded if they had a history of vaccine intolerance such as allergy, severe systemic disease of any kind, were treated with an anti-inflammatory drug within the past 30 days or an immunosuppressive agent within the past 60 days, were pregnant, or had been given an FPV-FCV-FHV vaccine other than one from the same line as the vaccine used in the study. Cats were maintained by their owners in conventional domestic environments, which included multicat households in some instances.

Site selection—The study was conducted at 38 companion-animal veterinary clinics in the United States and 2 clinics in Canada. These practices had clientele, vaccination use history, and records management that permitted compliance with the study protocol. At least 1 veterinarian at each site was designated as the investigator or examining clinician. Investigators were encouraged to enroll cats that had not received a vaccine for an extended period. All participating practices provided affidavits attesting to exclusive use of a vaccine from the same vaccine line as the test vaccine in the test cats during the period of previous vaccinations. Cat owners signed consent forms agreeing to participate in the study and comply with its protocol.

Test vaccine—A modified-live FPV-FCV-FHV vaccine combined with *C psittaci*[a] (ie, the test vaccine) was used to revaccinate eligible test cats on day 0 of the study. Vaccine was administered per label instructions (1 mL, SC). All prior vaccinations for FPV, FCV, and FHV were with a vaccine from the same line as the test vaccine, with or without the *C psittaci* component.

Serologic assays—Serum from each blood sample was frozen and sent to Cornell University Veterinary Diagnostic Laboratory (CUVDL) for testing. The laboratory was unaware of the vaccination history of the cats. Each sample was tested for hemagglutination inhibition (HI) titer for antibodies against FPV and serum neutralization (SN) titers for antibodies against FCV and FHV. Serial 2-fold dilutions were inoculated onto wells of a 96-well microtiter plate, incubated, and evaluated for endpoint detection. The VR953 strain of swine RBCs was used as the substrate for the HI assays. The C-14 strain of Crandell feline kidney (CRFK) cells was used as the substrate for FCV SN testing, and the C-27 strain of CRFK cells was used as the substrate for FHV SN testing. Cell substrates were obtained from the American Type Culture Collection. Titration endpoints were agglutination for HI assays and cytopathic effect for the SN assays.

A cat was considered to be a serologic responder to the respective test antigen if it was seropositive for antibodies against the antigen on day 0 or if analysis of the postvaccination serum sample revealed an anamnestic response (4-fold or greater increase in antibody titer vs the prevaccination [day 0] sample). Minimum antibody titers established by CUVDL were used to determine whether a cat was seropositive (HI titer for antibodies against FPV, ≥ 1:40; SN titer for antibodies against FCV, ≥ 1:32; and SN titer for antibodies against FHV, ≥ 1:16).

Lifestyle and disease risk questionnaire—On day 0, each cat owner completed a lifestyle and disease risk questionnaire for each cat. Cats were categorized into high- and low-risk groups on the basis of questionnaire responses. Cats were included in the low-risk group if they lived in households with 3 or fewer cats; if all of the cats in the household stayed indoors 100% of the time; and if they had not been to a kennel, groomer, or cat show for more than 24 hours during the preceding year. Any cat that did not meet the low-risk group criteria was classified as high-risk.

Study procedure—When each test cat was enrolled in the study (day 0), it was examined for general health, and a 0.5-mL sample of blood was obtained for FeLV and FIV diagnostic testing. A standard in-clinic ELISA test kit for FeLV p27 antigen and antibodies against FIV[b] was used to determine exposure to these agents. If the results of the FeLV and FIV ELISA were negative and the cat was confirmed to meet all inclusion criteria, approximately 5 mL of blood was collected from the jugular vein or other peripheral vein. Blood was collected in a serum separator tube, centrifuged, and the serum was placed in a plastic shipping tube labeled with the study, case number, and date, and stored frozen at −20°C. Immediately after blood sample collection, each cat was vaccinated per label instructions (1 mL, SC). Five to 7 days after vaccination, each cat was reexamined and a second blood sample was obtained and processed as before. Serum samples were frozen prior to shipment. The 2 serum samples were shipped on ice packs together to the diagnostic laboratory for serologic testing. Cats were observed for adverse reactions immediately after vaccination and monitored by the owners for 5 to 7 days after vaccination for development of adverse effects. After the second blood sample was collected, the cat's participation in the study was concluded.

On the basis of the period of time since last vaccination (TSLV), cats were categorized into 1 of the following 6-month groups: 12 to 18, 19 to 24, 25 to 30, 31 to 36, 37 to 42, 43 to 48, or > 48 months. The serologic response to the 3 test antigens was determined for each cat, and the antibody titer was assigned to the respective TSLV category.

Statistical analyses—Antibody titer values were transformed by a logarithm base 2 and analyzed with a general linear repeated-measures mixed model. The fixed effects of the model were the 6-month TSLV category, pre- or postvaccination sample time, and TSLV category by sample time interaction were determined. For each antigen, the prevaccination titer was compared with the postvaccination titer within the TSLV category if the sample time or TSLV category by sample time interaction was significant ($P \leq 0.05$). For each antigen, the TSLV categories were compared within sample time if the TSLV category or TSLV category by sample time interaction was significant ($P \leq 0.05$). Geometric mean (GM) antibody titers for each antigen at each sample time for each TSLV group were calculated by back-transforming the least-squares

means. The number of samples, GM values, and range of antibody titers were calculated for each TSLV category and sample time. A frequency distribution of the prevaccination antibody titers was calculated for each TSLV and risk category. In addition, GM values were compared between high- and low-risk categories within each TSLV category and sample time with a general linear repeated-measures mixed model.

Results

Cats enrolled in the study ranged in age from 2 to 17 years. On the basis of responses to the lifestyle and disease risk questionnaire, 86 of the 272 (32%) cats were classified as low risk and 186 (68%) were classified as high risk. The majority of cats (57.7%) had been vaccinated within the preceding 2 years, but more than one-fourth had not been vaccinated for 3 years or more, and 12.1% had not been vaccinated for 4 years or more. Geometric mean antibody titers and antibody titer ranges for each of the 3 antigens on day 0 at each 6-month TSLV interval were determined. Although some cats had antibody titers less than the minimum seropositive values recommended by CUVDL, GM antibody titers exceeded the minimum values for all antigens at all TSLV intervals.

FPV—For FPV, 263 of 272 (96.7%) cats were responders (ie, day-0 FPV HI titer ≥ 1:40 or a ≥ 4-fold increase in HI titer after day-0 vaccination) regardless of lifestyle. Eighty-four of 86 (97.7%) cats in the low-risk group and 179 of 186 (96.2%) cats in the high-risk group responded serologically (**Table 1**). For all TSLV categories, a nonsignificant increase in GM HI titers was detected after day 0 vaccination, except for the 12- to 18-month group, which had a nonsignificant decrease from 1,036 to 1,009. The only significant differences between high- and low-risk category cats for GM HI titers were in the prevaccination sample in the 31- to 36-month TSLV group and the prevaccination and postvaccination samples in the 43- to 48-month TSLV group; the low-risk category had higher GM HI titers.

FCV—For FCV, 266 of 272 (97.8%) cats were responders (day-0 SN titer ≥ 1:32 or 4-fold increase in SN titer after day-0 vaccination) regardless of lifestyle. Eighty-three of 86 (96.5%) cats in the low-risk group and 183 of 186 (98.4%) cats in the high-risk group responded serologically (**Table 2**). The GM titers at day 0 did not necessarily decline as TSLV increased. Comparison of GM titers before and after day-0 vaccination indicated that a significant serologic response to FCV occurred in all TSLV categories, except the 43- to 48-month and > 48-month groups. The only significant differences between high- and low-risk category cats were in the prevaccination sample in the 19- to 24-month TSLV group and the prevaccination and postvaccination samples in the 37- to 42-month TSLV group; the low-risk category had lower GM titers.

FHV—For FHV, 240 of 272 (88.2%) cats were responders (day-0 SN titer ≥ 1:16 or 4-fold increase in SN titer after day-0 vaccination) regardless of lifestyle. Eighty of 86 (93.0%) cats in the low-risk group and 160 of 186 (86.0%) cats in the high-risk group responded serologically (**Table 3**). Titers at day 0 were

Table 1—Geometric mean (GM) serum hemagglutination inhibition (HI) titers against feline panleukopenia virus in cats on day 0 and days 5 to 7 after revaccination. Cats were categorized by the 6-month interval since their last vaccination

Serologic response category	Overall (n = 272)	6-month interval since last vaccination (months)						
		12–18 (108)	19–24 (49)	25–30 (25)	31–36 (19)	37–42 (25)	43–48 (13)	> 48 (33)
Day 0 GM titer	NA	1,036	732	1,026	654	617	659	472
Day 0 titer range	NA	10–12,800	40–5,120	20–7,680	40–5,120	10–3,840	10–5,120	10–9,600
Days 5 to 7 GM titer	NA	1,009	787	1,246	719	665	698	600
Days 5 to 7 titer range	NA	10–7,680	40–5,120	20–5,120	40–3,840	30–3,840	10–5,120	10–12,800
No. of responders* overall	253	104	49	24	19	24	12	31
% Responder*	96.7	96.3	100	96.0	100	96.0	92.3	93.9
No. low risk (responders*)	86 (84)	36 (34)	14 (14)	7 (7)	4 (4)	8 (8)	7 (7)	10 (10)
No. high risk (responders*)	186 (179)	72 (70)	35 (35)	18 (17)	15 (15)	17 (16)	6 (5)	23 (21)

*Based on prevaccination HI titer ≥ 1:40 or ≥ 4-fold increase in postvaccination HI titer. NA = Not applicable.

Table 2—Geometric mean serum neutralization (SN) titers against feline calicivirus in cats on day 0 and days 5 to 7 after revaccination. Cats were categorized by the 6-month interval since their last vaccination

Serologic response category	Overall (n = 272)	6-month interval since last vaccination (months)						
		12–18 (108)	19–24 (49)	25–30 (25)	31–36 (19)	37–42 (25)	43–48 (13)	> 48 (33)
Day 0 GM titer	NA	430	433	219	180	323	430	687
Day 0 titer range	NA	4–81,920	24–6,144	16–4,096	24–2,048	8–6,144	64–10,240	32–30,720
Days 5 to 7 GM titer	NA	554	555	393	349	458	517	877
Days 5 to 7 titer range	NA	12–30,720	32–8,192	12–6,144	64–3,072	8–6,144	96–3,840	48–40,960
No. of responders* overall	266	107	49	24	19	21	13	33
% Responder*	97.8	99.1	100	96.0	100	84.0	100	100
No. low risk (responders*)	86 (83)	36 (36)	14 (14)	7 (7)	4 (4)	8 (5)	7 (7)	10 (10)
No. high risk (responders*)	186 (183)	72 (71)	35 (35)	18 (17)	15 (15)	17 (16)	6 (6)	23 (23)

*Based on prevaccination SN titer ≥ 1:32 or ≥ 4-fold increase in postvaccination SN titer. *See* Table 1 for remainder of key.

Table 3—Geometric mean (GM) SN titers against feline herpesvirus virus in cats on day 0 and days 5 to 7 after revaccination. Cats were categorized by the 6-month interval since their last vaccination

Serologic response category	Overall (n = 272)	6-month interval since last vaccination (months) 12–18 (108)	19–24 (49)	25–30 (25)	31–36 (19)	37–42 (25)	43–48 (13)	> 48 (33)
Day 0 GM titer	NA	41	46	41	39	27	45	36
Day 0 titer range	NA	4–512	6–1,024	4–256	6–256	4–128	16–512	4–256
Days 5 to 7 GM titer	NA	53	67	66	57	43	71	46
Days 5 to 7 titer range	NA	4–768	16–768	8–256	8–512	12–256	16–512	4–512
No. of responders* overall	240	91	47	23	18	20	13	28
% responder*	88.2	84.3	95.9	92.0	94.7	80.0	100	84.8
No. low risk (responders*)	86 (80)	36 (33)	14 (14)	7 (7)	4 (3)	8 (8)	7 (7)	10 (8)
No. high risk (responders*)	186 (160)	72 (58)	35 (33)	18 (16)	15 (15)	17 (12)	6 (6)	23 (20)

*Based on prevaccination SN titer ≥ 1:16 or ≥ 4-fold increase in postvaccination SN titer. *See* Table 1 for remainder of key.

relatively constant, within a 2-fold dilution, across all TSLV categories ($P > 0.05$). After day-0 vaccination, a significant increase in titers developed in all TSLV categories. There were no significant differences in titers between the high- and low-risk categories.

Adverse events—Adverse events that were possibly related to day-0 vaccination were reported in 8 cats. These sequelae were all characterized as mild and included signs of lethargy, pyrexia, alopecia, anorexia, weight loss, and hematuria. Clinical signs resolved in 6 cats either spontaneously or with appropriate treatment. Outcomes of the other 2 cats with lethargy, anorexia, or pyrexia were unknown. Whether there was a causative relationship between these adverse events and vaccination was not established.

Discussion

The central finding of our study was that for most cats, vaccination induced a serologic response to all 3 viral antigens that exceeded presumed protective values for an extended period, lasting in some instances 4 years or more. Results of other studies indicate that seropositive status for FPV, FCV, and FHV correlates with protection. Scott and Geissinger[14] found that detectable postvaccination **virus neutralizing** (VN) antibodies against FCV and FHV provided substantial protection against virulent challenge for 3 years or more. They also determined that postvaccination VN titers for FPV antibodies provided complete protection against challenge administered up to 7.5 years later. The seropositive thresholds for those VN assays were ≥ 1:10 for FPV, ≥ 1:4 for FCV, and ≥ 1:2 for FHV. Lappin et al[12] found that regardless of vaccine type or postvaccination interval, if detectable antibodies against FPV, FCV, or FHV were detected, cats were protected against virulent challenge. Minimum seropositive values in that study were HI titers for FPV > 1:10, and VN titers for FCV or FHV > 1:8. Interassay variation may exist in the serologic methods used in those studies versus those used in our study. However, the essential results of those studies are that even very low FPV, FCV, or FHV serum antibodies concentrations correlate with protection. Others have determined that a dog or cat that has developed an immune response after vaccination will possess immune memory cells that will activate a rapid and effective serologic response to exposure even if serum antibody titers have declined to low or undetectable concentrations.[15]

Serologic response to vaccination can vary depending on vaccine potency, strain variations, and whether a live or killed agent is used.[11,17] In our study, records verified that all cats were vaccinated with a vaccine from the same line of FPV-FHV-FCV vaccines throughout their lifetime, thus avoiding variations in immunizing antigens (in some cats, the vaccine included a *C psittaci* component). Cats were excluded if there was a known history of clinical disease caused by FPV, FHV, or FCV, minimizing the chance that serologic response was because of natural exposure. The same diagnostic laboratory was used for all serologic testing to ensure that uniform assay methods were used. Inclusion in the study was limited to adult cats, removing the chance that antibody titers were maternally induced. Prescreening procedures excluded cats considered at risk for immunosuppressive diseases or cats receiving medications that would influence serologic response. Thus, there was reasonable assurance that selection criteria or variations in methods and materials did not measurably influence duration and degree of serologic response to a specific FPV-FHV-FCV vaccine.

With the understanding that disease risk may be influenced by urban versus rural location, results of the lifestyle questionnaire suggested that most cats had substantial contact with other cats or environments that were a potential source of infectious disease. However, in our study, the greater opportunities for exposure among cats in the high-risk category did not appear to be associated with serologic response to vaccination at any of the 6-month TSLV intervals. This was possibly attributable to exclusion of cats with a clinical history of FPV, FCV, or FHV-related diseases. It has been hypothesized that high-risk cats are likely to encounter natural exposure and have resulting increases in antibody titers. Results of our study do not seem to support that contention for FCV, because we found only 3 intervals for which cats in the low-risk category had lower GM SN titers than those in the high-risk category. In all of these examples, the GM HI titers were > 1:32.

Although postvaccination increases in GM titers were < 4-fold for any TSLV interval, revaccination of seropositive cats often results in little or no serologic response because vaccine antigen is neutralized somewhat by preexisting antibodies. In a study[5] of 106 dogs that were vaccinated within the previous 1 to 4 years

with canine parvovirus, despite the fact that this virus is highly immunogenic,[17] only 1 dog had a 4-fold or greater increase in antibody titer after revaccination. Scott and Geissinger[14] reported strong anamnestic responses after FPV, FCV, or FHV challenge in vaccinated cats, but these marked increases did not appear until 14 to 28 days after exposure. Had antibody titers been measured beyond 5 to 7 days after revaccination in our study, somewhat greater serologic responses may have been detected.

Despite the generally long-lived serologic response to vaccination, a few cats were encountered in 16 of the 21 TSLV categories that had antibody titers less than the protective threshold on day 0. Even in the group with the shortest interval since last vaccination (12- to 18-month group), some cats had antibody titers on day 0 that were less than protective values and did not have a postvaccination anamnestic response for FPV (3.7% nonresponders), FCV (0.9% nonresponders), or FHV (15.7% nonresponders). Failure of some cats to develop a robust serologic response 12 to 18 months after vaccination suggests that annual revaccination for 2 years after a 2-dose primary regimen may be beneficial for a young cat with an immune system that may not be fully developed, especially if vaccination history is unknown. Other factors that can negatively affect an animal's ability to respond to vaccination include maternal antibodies, congenital or acquired immunodeficiencies, concurrent diseases, inadequate nutrition, immunosuppressive medications, and stress.

Although our study focused on serologic responses to vaccination, it should be noted that serum antibodies are not the sole source of protection. Cell-mediated immunity and rapid immune memory-cell response to revaccination, even when serum antibodies are undetectable, also contribute to protection.[5,10,14,15] Thus, failure to detect serum antibodies in vaccinated cats does not necessarily correspond with susceptibility to disease.[10-12] Antibodies are an indirect indication of the cell-mediated, T lymphocyte arm of the immune response, which is enabled by B lymphocytes. Thus, serum antibodies, even when detected months to years after vaccination, indicate that the animal has sufficient immunologic memory for a rapid anamnestic cellular or antibody response. Although serum antibodies may not be directly responsible for nullifying intracellular viral infection, they contribute to host defenses and are considered a viable indicator of immunity.[15]

Other studies have examined duration of serologic response to FPV, FCV, and FHV prior to experimental challenge. Scott and Geissinger[14] found that 2 primary doses of an inactivated FPV-FCV-FHV vaccine induced detectable VN titers for ≥ 3 years for all 3 antigens (n = 9 cats) and that VN titers for antibodies against FPV persisted ≥ 7 years.[14] Variable protection against virulent FCV or FHV challenge in those cats was observed, although all cats remained clinically normal after challenge with FPV. Lappin et al[12] found that 3 FPV, FCV, and FHV vaccines induced specific antibodies detectable by use of ELISA from 9 to 36 months after vaccination in some cats and that seropositive results had positive predictive value for protection against virulent challenge. In that study, all 15 vaccinated cats that were seropositive to FPV, all 38 vaccinated cats that were seropositive to FCV, and 19 of 21 vaccinated cats that were seropositive to FHV were resistant to challenge.

Determination of duration of immunity for human vaccines is conducted by collecting data on disease incidence and adjusting the vaccination frequency on the basis of the results. For example, the World Health Organization plans to discontinue oral poliomyelitis vaccination after no wild-type poliovirus transmission is detected in the world for 3 consecutive years by use of surveillance programs that are able to detect 1 case of nonpoliomyelitis-associated acute flaccid paralysis per 100,000 children who are < 15 years of age.[18] Hsia et al[19] have determined that the prevalence of Lyme disease must exceed 10% before vaccination with yearly boosters becomes more effective than no vaccination. A similar method to prospectively evaluate prevalence of disease in the large population of pets impacted by current vaccination protocols would encounter difficulties in collecting and analyzing the data.

The distribution of cats among the TSLV intervals revealed that 39.7% of cats received the traditional regimen of annual revaccination for the 3 core feline antigens, whereas 26.1% were vaccinated on a triennial or less frequent basis. Veterinarians often encounter cats that are vaccinated infrequently. One of the peripheral questions our study sought to answer was the risk of susceptibility associated with irregular or extended vaccination intervals in a natural exposure setting for high- versus low-risk cats. Thus, we selected a high percentage of cats that had been vaccinated at intervals > 1 year. The American Association of Feline Practitioners and Academy of Feline Medicine now recommend revaccination against FPV, FCV, and FHV at 3-year intervals after primary vaccination and annual revaccination the first year,[3] and the data in our study seem to support that recommendation, regardless of the cat's lifestyle-associated risks. Recently, similar recommendations were made by the AVMA Council on Biologic and Therapeutic Agents.[4]

It should also be recognized that historic immunization practices based on annual revaccination have resulted in excellent disease control for the antigens evaluated in this study. The effects of moving to extended interval vaccination on feline population immunity are unknown. In humans, as pertussis (a respiratory disease readily controlled by an efficacious vaccine) became rarer, attention shifted from disease prevention to possible adverse events associated with vaccination and resulted in antivaccine movements in some countries. One study[20] revealed that the incidence of pertussis was lower by a factor of 10 to 100 in countries in which high vaccine coverage was maintained than in countries in which vaccination programs were compromised by antivaccine movements.

Vaccines should be administered via the same principles that apply to pharmaceuticals. They should be selected thoughtfully, administered appropriately, and the animal should be monitored for response. The objectives of companion animal vaccination are to protect the maximum number in the population at risk, vaccinate each animal no more frequently than neces-

sary, and vaccinate only for infectious agents for which a reasonable risk of exposure and disease exists.

[a]Felocell 4, Pfizer Inc, New York, NY.
[b]Snap FIV antibody/FeLV antigen test, IDEXX Laboratories, Westbrook, Me.

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Tuberculosis & other Mycobacterial Diseases in Cats

Tuberculosis and other Mycobacterial Diseases in Cats

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INTRODUCTION

Several species of mycobacteria can cause disease in veterinary species, being either primary pathogens, or becoming pathogenic under certain circumstances.

Tuberculosis can be caused by a number of different, but closely related, bacteria. Members of the tuberculosis complex include *Mycobacterium (M.) tuberculosis*, *M. bovis* and *M. microti*. *M. tuberculosis* causes over 90% of tuberculosis in man, but rarely infects other mammals, except for dogs. *M. bovis* is the main cause of tuberculosis in cattle. It can also infect various other mammals, including humans, dogs, cats and pigs. *M. microti* causes tuberculosis in voles and cats (in the latter it was previously termed *M. microti*-like and has culture characteristics between *M. tuberculosis* and *M. bovis*). *M. avium* causes tuberculosis in birds, and can also infect man, dogs and cats. *M. avium-intracellulare* complex (MAC) are mainly saprophytic organism, but it is often considered with the tuberculosis complex, since it can cause clinical disease indistinguishable from that caused by members of this group.

Other potentially pathogenic mycobacteria include *M. lepraemurium,* which causes leprosy in rats, and a similar, or possibly the same, organism which causes feline leprosy. Opportunistic mycobacteria are usually saprophytic, but a number of species have been reported to cause disease in cats. These include *M. chelonae-abscessus, M. fortuitum / peregrinum* group, *M. smegmatis, M. phlei, M. genavense, M. simiae, M. thermoresistible, M. xenopi* and *M. terrae* complex.

Mycobacterial syndromes seen in cats therefore include tuberculosis, feline leprosy and opportunistic mycobacteriosis. All three syndromes have been reported in the UK, where the majority of cases appear to be cutaneous in nature. All three syndromes can present with nodules, draining tracts and/or ulceration. In some cases, the disease may become generalised secondary to skin inoculation, but only occasional cases present with primary systemic disease. Where systemic disease is seen, infection with a member of the tuberculosis group is most likely. In many cases of feline mycobacteriosis, infection can be related to percutaneous injury, contamination via soil or the presence of devitalised tissue. These factors tend to be reflected in the distribution of the lesions.

TUBERCULOSIS

CLINICAL BACKGROUND:

Epidemiology and aetiopathogenesis:

In cats, tuberculosis has classically been described as being caused by *M. bovis.* Historically, infection resulted from the ingestion of milk from tuberculous cattle. With the virtual eradication of tuberculosis from the national herd there has been a marked decline in the prevalence of the disease seen in cats.

Currently, tuberculosis in cats is seen infrequently. When it is diagnosed it is usually caused by infection with either the cattle form of the infection *(M. bovis* [41 cases]) or the vole form *(M. microti* [22 cases - recent figures from Keith Jahans, Veterinary Laboratories Agency, 2004, data collected since 1980). Infection of cats with *M. tuberculosis* is incredibly rare, probably because cats are naturally very resistant to it. (Interestingly, this is quite different from the picture seen in humans; where over 90% of cases result from infection with *M. tuberculosis*, approximately 1% is caused by *M. bovis* and disease due to *M. microti* is incredibly rare). Cats can occasionally develop disease due to infection with MAC.

The current epidemiology of tuberculosis in cats is still unclear. While we do see occasional clinical cases, few are believed to relate to direct infection from cattle. This is because when tuberculosis is gained by drinking contaminated cows milk the infection settles within the cat's intestines, and disease results in diarrhoea and weight loss. It is probably because almost all cows' milk is now pasteurised that this type of tuberculosis is currently very rare. The tuberculosis that we now see most frequently in cats affects their skin; where it causes non-healing sores and lumps that fail to heal. This is often associated with swollen lymph nodes, especially those under the chin, and some cases show only the swollen lymph nodes. In chronic cases, where the infection has spread to the cat's lungs, they may develop a soft cough or have difficulty breathing.

It is important to try to determine how cats are becoming infected. If we look into possible risk factors we find that most of the cats are keen hunters, regularly catching small rodents. Interestingly, studies have shown that in the UK wild mice and voles quite often carry *M. microti,* while moles and rats can carry *M. bovis.* It therefore most likely that cats become infected by hunting small wide rodents. This also accounts for the distribution of the skin lesions seen on these cats, which occur most frequently on the face and legs, i.e. the areas most likely to be bitten when playing with prey. In some areas of Britain *M. bovis* has become endemic in badgers. While cats and badgers rarely interact directly, there may be a potential risk for cats to become infected via local environmental contamination. *M. bovis* can also be endemically present in many other species of free-ranging wildlife, e.g. deer; so the risk of feline infection will vary in each country dependent on the likely interaction between these species and domestic cats.

All members of the tuberculosis complex pose potential zoonotic risks. However, to date, there have been no reported cases of cats passing tuberculosis onto humans. By far the greatest tuberculosis risk to humans is spending time with infected humans or, less frequently, handling infected cattle.

Interestingly, *M. tuberculosis* and *M. bovis* can both cause reverse zoonoses and there have been a small number of cases where humans have infected their cats (usually with *M. bovis*). This may be significant because with the current increase in human tuberculosis associated with HIV infection and poor housing, we may see a concurrent increase in feline tuberculosis caused by these organisms.

Predisposition:

Most cases of feline tuberculosis are probably subclinical in nature. Infection usually occurs after protracted exposure, e.g. repeated exposure to infected small mammals, living on a farm housing tuberculous cattle, or living for prolonged periods with infected humans or poultry. Tuberculosis is therefore seen mainly in adult cats, and interestingly, is seen most commonly in males. No evidence of immunosuppression has been found and those cats tested for FIV and FeLV have usually been negative.

Clinical signs:
Depending on the route of infection, affected cats may present with systemic signs related to the alimentary, and/or respiratory tracts, or with localised disease affecting the skin. Currently, the most usual presentation for tuberculosis in cats is the cutaneous form, with respiratory and alimentary forms being seen less frequently.

In the cutaneous form the lesions probably arise from infected bite wounds, local spread or haematogenous dissemination to the skin. The lesions often involve the face, extremities, tail base or perineum, i.e. "fight and bite sites". Less frequently they involve the ventral thorax and tail base. They generally take the form of firm, raised, dermal nodules, ulceration, or non-healing wounds with draining sinus tracts. Extension of granulomatous tissue may in some cases involve the subcutaneous structures, muscle and/or bone. Skin lesions are commonly associated with either local or generalised lymphadenopathy. On occasion, submandibular or prescapular lymphadenopathy may be the only clinical finding.

When the infection spreads to the lungs, or where it is acquired through inhalation, tubercles arise in the lungs and/or hilar lymph nodes and affected cats present with weight loss, anorexia, dyspnoea and coughing.

In the alimentary form, tubercles arise in the intestines and/or mesenteric lymph nodes. Affected cats commonly develop intestinal malabsorption and present with weight loss, anaemia, vomiting and diarrhoea. Occasionally tubercles arise in the tonsils, resulting in signs of oropharangeal disease.

A range of clinical signs may be seen with disseminated disease. These include splenomegaly, hepatomegaly, pleural or pericardial effusions, generalised lymphadenopathy, weight loss and fever. Lameness may result from bone involvement. Granulomatous uveitis and signs referable to central nervous system involvement have been seen in some cases.

DIAGNOSTIC TECHNIQUES:
Non-specific tests: A thorough evaluation of the patient is necessary to assess the extent of local infection and the degree of systemic involvement. Changes in serum biochemistry and haematology, if present, are non-specific and vary with the severity of the disease. However, hypercalcaemia has been seen in a number of cases and appears to correlate with a poorer prognosis. Radiography can be useful in the appraisal of lung involvement. However, changes are very variable and include tracheo-bronchial lymphadenopathy, interstitial or miliary lung infiltration, localised lung consolidation, or pleural effusion. Abdominal radiography may reveal hepato- or splenomegaly, abdominal masses, mineralised mesenteric lymph nodes, or ascites. Bone lesions tend to consist of areas of bony lysis and sclerosis, osteoarthritis, discospondylitis or periostitis.

Specific tests: Specific tests for the diagnosis of tuberculosis have been investigated in cats, but have generally proved unhelpful. Unlike other species, cats do not react strongly to intradermally administered tuberculin and the results from intradermal skin testing are unreliable. Tests for specific serum antibody responses have also proved unhelpful.

To confirm mycobacterial involvement, aspirates and/or biopsy samples of affected tissue should be stained with Ziehl Neelsen (ZN) or other specific special stains. The number of acid fast bacilli seen within affected macrophages may be variable, depending on the species of mycobacteria involved, the location of the granuloma and, probably most importantly, the nature of the cat's immune response. While finding acid fast bacilli confirms the presence of mycobacteria, it is essential to culture the organism to determine the exact species involved. Once the species has been identified it is possible to evaluate zoonotic risk, potential sources of infection, and feasible treatment options. Unfortunately, many samples that are seen to have ZN positive organisms fail to culture positive, and even those that do typically take approximately two months.

Correct handling of biopsy material:
In practice, this usually involves taking a biopsy from a case where mycobacterial disease is only one of a large number of possible differential diagnoses. If in-house facilities are available for ZN staining, this can be performed on aspirates or biopsy impression smears. However, in most cases biopsy material must be sent to a veterinary diagnostic laboratory. It is practical to collect the biopsy, cut it into three pieces, fix one in formalin for histopathological examination and ZN staining and, pending

results, place one in a sterile container and freeze it. Where other bacterial infections are suspected, the third sample should be sent unfixed for routine bacterial culture at which time ZN staining can also be requested. That way, if the sample is found to have ZN positive organisms, the frozen portion can be defrosted and sent to a either the Veterinary Laboratories Agency or a Mycobacterial Reference Laboratory for specialist culture (see end of text for addresses).

Until the organism has been properly characterised, it should be considered a potential human pathogen.

Whenever handling potentially tuberculous material it is necessary to take certain precautions. In the UK, the law dealing with material KNOWN to be tuberculous is very exact and requires the use of specialist laboratories. However, the law relating to material taken from animals where tuberculosis is only one of a number of possible differentials is quite different. In the latter case routine aseptic practices are generally adequate, although gloves should be worn when handling either the biopsy site or the biopsy material. ZN staining of aspirates or biopsy impression smears may be performed where suitably equipped in-house laboratories are available (correct work surfaces, separate refrigerator, etc.). However, before undertaking in-house diagnostics it is prudent to contact the local Health and Safety Executive for guidance.

While tuberculosis in cats is not currently a noticeable disease DEFRA expects to make the diagnosis of *M. bovis* infection notifiable in all mammals (except humans) by the end of 2004. It is therefore essential to inform the local DEFRA office of any confirmed cases, and when a confirmed case is euthanased it is advisable to have the body cremated.

Histopathology:
Histopathology of affected tissue generally reveals granulomatous inflammation, with foamy macrophages containing variable numbers of acid fast bacilli.

MANAGEMENT:
Interim Management: Deciding to treat a case of suspected feline tuberculosis is always contentious. Before undertaking treatment it is important to address a number of points:

- *Consider the potential zoonotic risk.* All members of the affected cat's household must be involved in any decision making. Particular consideration should be given to those individuals most susceptible to the infection, e.g. household members with HIV infection, or those undergoing chemotherapy or organ transplantation. We strongly advise against treatment where such individuals may be exposed to an infected cat. We also advise against treatment if the affected cat has generalised disease, respiratory tract involvement, or extensive draining cutaneous lesions, since any of these findings may increase the risk of transmission. In addition, uncomplicated cutaneous disease appears to carry the most favourable prognosis.
- Where the cat is a suitable candidate, it should be emphasised that treatment is long-term and difficult to maintain given patient non-compliance, the inherent toxicity of some of the drugs and the financial costs involved. In some cases the drugs may at best suppress the disease and indefinite treatment may be required.
- Tailoring treatment is difficult as sensitivity testing does not always correlate with *in vivo* results.
- Surgical excision of small cutaneous lesions may be considered, but is successful in only a few cases. Debulking larger lesions risks wound dehiscence and local recurrence of infection.

Pending a definitive diagnosis, interim therapy with enrofloxacin (or another fluoroquinolone) is recommended; but only in cases with localised lesions. If additional signs of regional spread or systemic involvement are present (e.g. radiographic changes or hypercalcaemia), it is strongly recommended that double or triple therapy be initiated immediately (Table 1). This not only gives the best chance of clinical resolution, but also decreases the potential for the mycobacteria to develop resistance to the fluoroquinolone. This is an important consideration since generating drug resistance will be detrimental not only to the individual cat, but may also endanger human patients.

Before deciding on continued treatment it is highly desirable to know exactly which form of mycobacteria is responsible. This is because it is strongly inadvisable to continue treating a cat with *M. tuberculosis* or disseminated *M. bovis* (and in the UK the law may shortly demand the euthanasia of any cat confirmed to have *M. bovis*). Unfortunately, in many cases it is not possible to culture

organisms from tissue samples that have been seen to have positive ZN staining. In addition, molecular PCR techniques have still to be perfected. Because of this is it essential to council owners very carefully, making them aware of all of the potential risks and complications.

Treatment of choice:

Ideally, anti-tuberculosis treatment should consist of an *initial* and a *continuation* phase. The initial phase usually requires at least three drugs and lasts for two months, while the continuation phase requires two drugs and lasts for perhaps a further four months, depending on the type and extent of the disease. In those cats where triple therapy is not feasible, treatment should still involve at least two drugs and should be given for a minimum of six to nine months.

Traditionally, the rifampicin-isoniazid-ethambutol combination has been considered the most effective regime for the treatment of tuberculosis in animals. However, some newer and less toxic drugs are worth appraisal. The fluoroquinolones, e.g. enrofloxacin and marbofloxacin, have potential in the treatment of feline tuberculosis, as well as opportunistic mycobacteriosis. However, they do not appear to be effective against MAC infection. Clarithromycin is a modern macrolide which is used in the treatment of human tuberculosis; while there is little published information on its use in cats, it appears to be effective when given in combination with rifampicin and/or a fluoroquinolone. To date, the only side effect seen with clarithromycin treatment has been pinnal or more generalised erythema which resolves on discontinuation of the drug. A useful once daily alternative to clarithromycin is azithromycin. From clinical experience gained over the past 10 years we recommend treatment consisting of an initial phase of rifampicin-fluoroquinolone-clarithromycin/azithromycin, followed by a continuation phase of rifampicin and either fluoroquinolone or clarithromycin/azithromycin (Table 1).

In cases where resistance develops, the rifampicin-isoniazid-ethambutol combination may be considered. If necessary, ethambutol can be substituted with dihydrostreptomycin or pyrazinamide. However, where *M. bovis* has been confirmed, pyrazinamide is not recommended due to the organism's natural resistance. Rifampicin and isoniazid are more effective and less toxic than ethambutol and dihydrostreptomycin and consequently are more appropriate choices if only two drugs are required.

Prognosis:

The prognosis depends on the type of mycobacteria involved, and the extent and severity of the infection. While many cases, especially those caused by *M. microti* infection, have responded very favourably to treatment, and have achieved apparent cure or long-term remission, the prognosis should always be stated as guarded.

FELINE LEPROSY

CLINICAL BACKGROUND:

Epidemiology and aetiopathogenesis:

Infection with *M. lepraemurium* is largely assumed as the organism cannot be cultured using standard techniques. However, recent reports from Australia show that feline leprosy can take one of two different forms and that while disease in younger cats does appear to be caused by *M. lepraemurium*, the disease seen in older cats appears to be caused by a novel, but as yet undefined, mycobacterial species. Infection is believed to be gained by the introduction of the organisms through bite wounds from rodents. However, this is not proven and it is also possible that infection is gained via soil contamination of cutaneous wounds. A yet, there is no known zoonotic potential for this disease.

Predisposition:

There is no breed or gender predisposition but adult cats are more often affected. The prevalence of feline leprosy is higher in areas with a temperate maritime climate, e.g. Australia, New Zealand, Europe (UK, the Channel Islands, the Netherlands), western Canada and western parts of the USA (California, Oregon).

Clinical signs:

Feline leprosy is primarily a cutaneous syndrome. Single or multiple nodules, which may be haired, alopecic or ulcerated, may be seen on the head, limbs and occasionally the trunk. They are non-painful and freely mobile. Regional lymphadenopathy may be present but systemic disease is rare. In Australia this disease appears to have two different forms: one type affecting young cats, which initially develop localised nodular, often ulcerated, lesions on the limbs, which progress rapidly, while the other type affects older cats, which develop more generalized skin involvement with no ulceration and a slower clinical progression.

DIAGNOSTIC TECHNIQUES:

Cytology and histopathology (with the use of special stains) are the major methods of diagnosis. In young cats there are typically few acid fast organisms present. However, in older cats the lesions often contain large numbers of acid fast organisms, which can be clearly seen within macrophages. Culture is usually unrewarding, but should be performed in all suspect cases as the clinical signs and histopathology of feline leprosy can mimic those of feline tuberculosis. Molecular PCR techniques are currently being investigated and do show promise. The diagnostic approach discussed previously for tuberculosis should be followed.

MANAGEMENT:

Interim management: A fluoroquinolone (Table 1.) should be used pending diagnosis.

Treatment of choice: Surgical removal of small nodules is recommended. Clofazamine (Table 1.) has been used in a limited number of cases where surgical removal was difficult. Dapsone is considered too toxic for use in cats.

Prognosis:

The prognosis is good and spontaneous resolution may occur.

OPPORTUNISTIC MYCOBACTERIAL DISEASE

CLINICAL BACKGROUND:

Epidemiology and aetiopathogenesis:

This syndrome is caused by saprophytic, usually non-pathogenic, organisms which are found in soil, water and decaying vegetation. The "fast growing" representatives of this mycobacterial group are most commonly implicated in feline skin disease. However, as our ability to recognise the implications of "bite site" lesions improves, along with our access to the expertise of the specialist laboratories, slow growing variants are being recognised more frequently, as they are in human medicine.

The following organisms have been implicated in causing this syndrome; *M. chelonae-abscessus, M. fortuitum / peregrinum* group, *M. smegmatis* and *M. phlei.* Other opportunist mycobacteria that have been found causing disease in cats include *M. genavense, M. simiae, M. thermoresistible, M. xenopi* and *M. terrae* complex. All of these organisms can cause disease through contamination of cutaneous wounds and are particularly pathogenic if inoculated into adipose tissue. Entry through the gastrointestinal or respiratory tracts is rare.

Predisposition:

In general, cats appear to be predisposed to infection with this group of mycobacteria. Adult cats with a hunting or fighting lifestyle are more likely to be affected. Disease caused by these organisms is rarely reported in the UK and appears more common in tropical and subtropical areas of the world. However, difficulties associated with diagnosis may influence its true prevalence. Unlike the situation in humans, immunosuppression has only been found in a small number of the affected cats.

Clinical signs:

Many of the different species of opportunistic mycobacteria produce similar clinical syndromes. The most common of which is typified by panniculitis, where multiple, punctate draining tracts occur with a "salt and pepper shaker" appearance. These are associated with subcutaneous nodules and coalescence produces large areas of ulcerated, non-healing tissue. Affected areas can be extremely painful. The inguinal fat pads, flanks and the tail base are affected most frequently. However, any area may be affected if it is prone to injury (and has sufficient subcutaneous fat). The lesions may be exacerbated by surgery and dehiscence associated with satellite lesions is common. Although systemic spread is rare, fever, anorexia and reluctance to move may be seen. Primary pulmonary infection with *M. fortuitum* and dissiminated infection with *M. smegmatis* have been reported and may have arisen from non-cutaneous routes of entry.

DIAGNOSTIC TECHNIQUES:

Histopathology:

Pyogranulomatous panniculitis is seen and should automatically warrant a search for mycobacteria. These organisms are difficult to identify in histopathological sections even when acid fast stained, but the use of modified Fite's or rapid ZN methods will increase the sensitivity of detection.

Culture:

Culture from a biopsy specimen is the diagnostic test of choice. The organisms are usually relatively easy to grow on Lowenstein Jensen media, but molecular PCR techniques are also currently being investigated.

MANAGEMENT:

Interim management: A fluoroquinolone is the drug of choice while waiting for culture.

Treatment of choice:

This is controversial and evaluation of the individual case is required. Ideally, antimicrobial therapy should be determined by culture and sensitivity where possible. This is because different species of opportunist Mycobacteria have differing sensitivity patterns. *M. fortuitum* and *M. smegmatis* are sensitive to fluoquinolones, while *M. chelonae* is sensitive to clarithromycin. It is possible that double or triple therapy with a combination of fluoquinolone, clarithromycin or azithromycin and/or rifampicin should be considered as for the tuberculosis syndromes (Table 1.). Antibiotic therapy should be continued for protracted periods of time, ie. six to twelve weeks. Surgical intervention should be radical and planned with the same precision as removing a locally invasive neoplasm. Antibiotic therapy in combination with surgery has been recommended.

Prognosis:
Prognosis is poor to guarded. The prognosis deteriorates further when there have been previous unsuccessful attempts at surgery.

References and further reading:
Greene, C.E. and Gunn-Moore, D.A. Mycobacterial infections. In: *Infectious Diseases of the Dog & Cat*, 3rd edition, Greene, C.E. (ed.). W.B. Saunders Co., Philadelphia, PA, 1998; pp.313-321

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Malik, R., Hunt, G.B., Goldsmid, S.E., Martin, P., Wigney, D.I. & Love, D.N. (1994) Diagnosis and treatment of pyogranulomatous panniculitis due to *Mycobacterium smegmatis* in cats. *J Sm An Pract.* **35**, 524-530

Mundell, A.C. *Mycobacterial skin diseases in small animals.* In: Kirk's Current Veterinary Therapy, XII. Bonagura, J. (Ed.). W.B. Saunders, Philadelphia, PA, 1995; pp.662-625

Studdert, V.P. & Hughes, K.L. (1992) Treatment of opportunistic mycobacteria infections with enrofloxacin in cats. *JAVMA* **201**, 1388-1390

Table 1. Potentially useful drugs for the treatment of feline mycobacterial disease.

Uses	Drug (Trade name)	Dose (mg/kg)	Interval (hours)	Toxicity
1st line tx for TB & opportunistic myco. infections[a]	Enrofloxacin	5 per os	12-24	Retinal degeneration.
	Marbofloxacin	2 per os	12-24	Retinal degeneration.
1st line tx for TB	Rifampicin[b]	10-20 per os	12-24	Hepatotoxicity, induction of liver enzymes, discoloration of body fluids.
1st line tx for TB	Clarithromycin[bc]	5-10 per os	12-24	Pinnal or generalised erythema.
	Azithromycin	7-15 per os	24	G-I signs?
2nd line tx for TB	Isoniazid[b] (Sold in combination with rifampicin +/- pyrazinamide)	10-20 per os	24	Hepatotoxicity, peripheral neuritis.
2nd line tx for TB	Dihydro - streptomycin[b]	15 im	24	Ototoxicity.
2nd line tx for TB[d]	Pyrazinamide[b]	15-40 per os	24	Hepatotoxicity.
Second line tx for TB	Ethambutol[b]	15 per os	24	Optic neuritis.
Tx for leprosy	Clofazamine[b]	8 per os	24	Hepatotoxicity.
2nd line tx for opportunistic myco. infections	Doxycycline	5-10 per os	12	G-I signs

tx - treatment, TB - tuberculosis, im - intramuscularly

[a] Not effective against MAC infection.

[b] **These drugs are not licensed for use in cats**

[c] Doses are extrapolated from human recommendations since there is little information published relating to the use of clarithromycin in the cat.

[d] Not effective against *M. bovis* infection

Second line treatments for tuberculosis should be reserved for resistant infections only.

Drugs licensed for human use can be obtained by veterinary prescription from larger chemists.

Useful addresses in the UK:

Dr. Danièlle Gunn-Moore, Senior Lecturer in Feline Medicine,
University of Edinburgh Small Animal Hospital,
Easterbush Veterinary Centre,
Roslin,
Midlothian,
Scotland, EH25 9RG
Tel: 0131 650 7650
Email: Danielle.Gunn-Moore@ed.ac.uk

Rachel Dean, Feline Fellow,
Feline Centre, Department of Clinical Veterinary Studies,
University of Bristol Veterinary School,
Langford House,
Langford,
North Somerset, BS18 7DU *(check post code)*
Tel: 0117 920 9577
Email: *(check email)*

Contact either of these people to discuss the case in more detail. Rachel Dean is currently trying to collate all of the cases in cats in the UK so that we can gain a better understanding of the presentation, causes, and treatment responses of the condition.

Dr. Keith Jahans,
Veterinary Laboratories Agency (DEFRA),
Weybridge, UK.
Telephone number: 01932 357280
Email: k.jahans@vla.defra.gsi.gov.uk

All potential cases should be reported to here. The VLA is currently willing to undertake culture and confirmation free of charge. If, and when, M. bovis infection becomes notifiable in cats it will be essential to contact DEFRA (ie. the VLA).

Regional Centre for Mycobacteriology,
Public Health Laboratory Service (PHLS),
Llandough Hospital,
Penlan Road,
Penarth,
Cardiff, CF64 2XX
Telephone number: 02920 716408

This laboratory is the most experienced of the human laboratories at culturing mycobacteria from cat samples. The cost for primary isolation is approximately £50. (Costs as of 2004). It is always advisable to contact the laboratory prior to sending samples.

Feline Advisory Bureau,
Taeselbury,
High Street,
Tisbury,
Wiltshire, SP3 6LD.
Tel: 0870 742 2278 Fax: 01747 871873
Email: information@fabcats.org

Contact the FAB for more information on tuberculosis in cats, and information on what to do if you have a suspected case.

Newly Emerging Infectious Diseases

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Over the past ten years there has been a dramatic increase in our recognition and understanding of infectious disease. With the advent of vaccines and antibiotics, society began to think that it had beaten infectious disease and that epidemics would be a thing of the past. Unfortunately, as bacteria developed antibiotic resistance, and human immunodeficiency virus (HIV) began to wreak havoc with global populations, our interest in infectious disease has had to be rekindled.

Reasons for the increase in our recognition of infectious disease:
Advances in diagnostics have improved our ability to detect -

- Previously unrecognised infectious organisms
- Previously recognised organisms in previously unknown hosts or situations

Advances in our knowledge of disease pathogenesis (cause and mechanism of disease) has increased our understanding of -

- The role of insidious infections in chronic diseases
- The role of insidious infections in immune-mediated diseases

Changing population dynamics have led to -

- Previously recognised organisms causing new diseases in their recognised hosts
- Previously recognised organisms infecting new hosts

Advances in diagnostics:
The drive to find a cure for human acquired immunodeficiency syndrome (AIDS) has lead the way in the global effort to better understand infectious disease. The resulting advances in molecular technology have significantly improved our ability to detect many pathogens. Because of this, new infectious diseases have been recognized in most species. Technical advances have also improved our ability to understand how the interaction between infectious organisms and the host species can result in disease.

Understanding pathogenesis:
With advances in our understanding of disease pathogenesis we have to re-define our concept of 'infectious disease'. No longer can we think that infection only causes acute disease that classically fulfils Koch's postulates of cause and effect. We now know that some diseases result from chronic, less obvious, infections. Progressively more diseases are being identified that, while being associated with the presence of a particular pathogen (infectious disease-causing agent), require a number of other factors to be present before disease becomes apparent. For these diseases to develop there has to be a specific interaction between the infectious organism, host factors (particularly genetics), and the environment.

Unfortunately, where the percentage of a population that is infected with a particular pathogen is high, but only a few individuals have the necessary factors required for clinical signs to develop, it can be very difficult to establish a causal relationship. Serological surveys have been largely responsible for recognizing the role of infectious organisms in this type of disease. This type of survey looks for the presence of antibody within a very large number of people's blood to indicate how many of those people have been previously exposed to a particular organism. After detecting a serological relationship it is then possible to use more complex molecular biology techniques to detect the pathogen within a particular individual or a particular pathological lesion. Examples of this type of infection include *Helicobacter spp.*, gastric ulceration and neoplasia; *Bartonella henselae* and Cat Scratch Disease, and possibly; Borna disease virus and some psychiatric disorders.

Changing population dynamics:
Populations are changing. People are living in progressively larger urban groups, and international travel is now commonplace. This allows for rapid spread of disease. Also, as the global human population increases, the demand for housing means that previously unexplored habitats are being developed, new pathogens are being exposed, and old pathogens are finding new hosts. Examples

of infections which have crossed between species because of altered population dynamics include equine morbillivirus, which has passed from bats, through horses, to cause disease in humans in Australia; canine distemper virus which is now causing disease in a number of large cat species, particularly lions, in the Serengeti; severe acute respiratory syndrome (SARS) which is caused by a coronavirus which appears to have been passed from civet cats in China to humans; Avian influenza virus (H5N1), which has killed domestic and captive wild felids in Thailand; and West Nile Virus, which is now present in the USA, being spread by mosquitoes to many wild and captive birds, as well as to horses and humans.

Increasing demand for cheap food has resulted in a growing number of food-related infections. These range from classical types of food poisoning, to the bovine and feline spongiform encephalopathies (BSE and FSE), and variant Creutzfeldt-Jakob disease (vCJD). Any relationship between vCJD, BSE and Chronic Wasting Disease (CWD) of White-Tailed Deer and Elk in the USA has still to be determined.

On a more domestic scale, particularly in urban environments, there is an increasing tendency to keep pet animals within the family home. This has lead to the realization that a number of pathogens can cross between domestic species. While some of these pathogens probably always had this capacity, (e.g. *Bordetella bronchiseptica,* one of the causes of 'Kennel Cough'), others have altered their genetic make-up in order to do so (e.g. canine parvovirus).

Overall, there has been a particular increase in the recognition of zoonotic conditions (diseases that can be spread from animals to humans). Since three quarters of all emerging human pathogens are zoonotic in nature is it very important that we raise our general awareness of this type of disease, and monitor closely for any evidence of interspecies transfer of infections.

Infectious diseases that have been recently recognised in cats:
An increasing number of infectious diseases are being recognised in cats for the same reasons as they are being recognised in other species. We will be discussing only a selected few in this lecture. Infections that are of most importance are those that can spread between cats and dogs, and those that have zoonotic potential. While some pathogens appear to be causing disease in cats for the first time (e.g. Canine parvovirus, and feline spongiform encephalopathy), others have probably been present for years, but have only been recently recognised (e.g. *B. bronchiseptica*, and some strains of mycobacteria). Another important group of organisms are those which, as yet, have poorly defined disease potential in cats, but are of particular importance because of their zoonotic potential (e.g. *Bartonella henselae,* and Borna disease virus).

Canine parvovirus (CPV)

Aetiology:
Canine parvovirus (CPV) is closely related to feline parvovirus (FPV, also termed feline panleucopenia virus).

Reason for interest:
While FPV has not been shown to cause disease in dogs, some CPV isolates have been shown to cause disease in cats. CPV was first recognised in 1978 in USA, Europe and Australia. It is believed that the virus mutated from FPV, possibly via passage through wild foxes. The initial strain of CPV (CPV-2) was unable to infect or cause disease in cats. However, within a few years of its arrival further mutation lead to the generation of CPV-2a, CPV-2b and then CPV-2c. Both CPV-2a and CPV-2b are known to cause disease in cats. It is now estimated that these viruses, rather than FPV may cause 10-20% of parvovirus disease that is seen in cats.

Geographical distribution:
Like FPV, both CPV-2a and CPV-2b have a world-wide distribution.

Signalment:
While disease due to FPV is seen most frequently in unvaccinated kittens of 3-5 months of age, it can also be seen in kittens as young as four-weeks, and in cats of up to a year of age. Disease is seen infrequently in kittens of less than three months because prior to this the kittens are usually protected by maternally derived antibody (from the colostrum). Disease may occasionally be seen in kittens from well-vaccinated pedigree breeding catteries. This may result from very high levels of environmental contamination.

Disease due to CPV-2a and CPV-2b is most likely to arise when young dogs and cats are kept together in large groups, e.g. poorly run rescue centres.

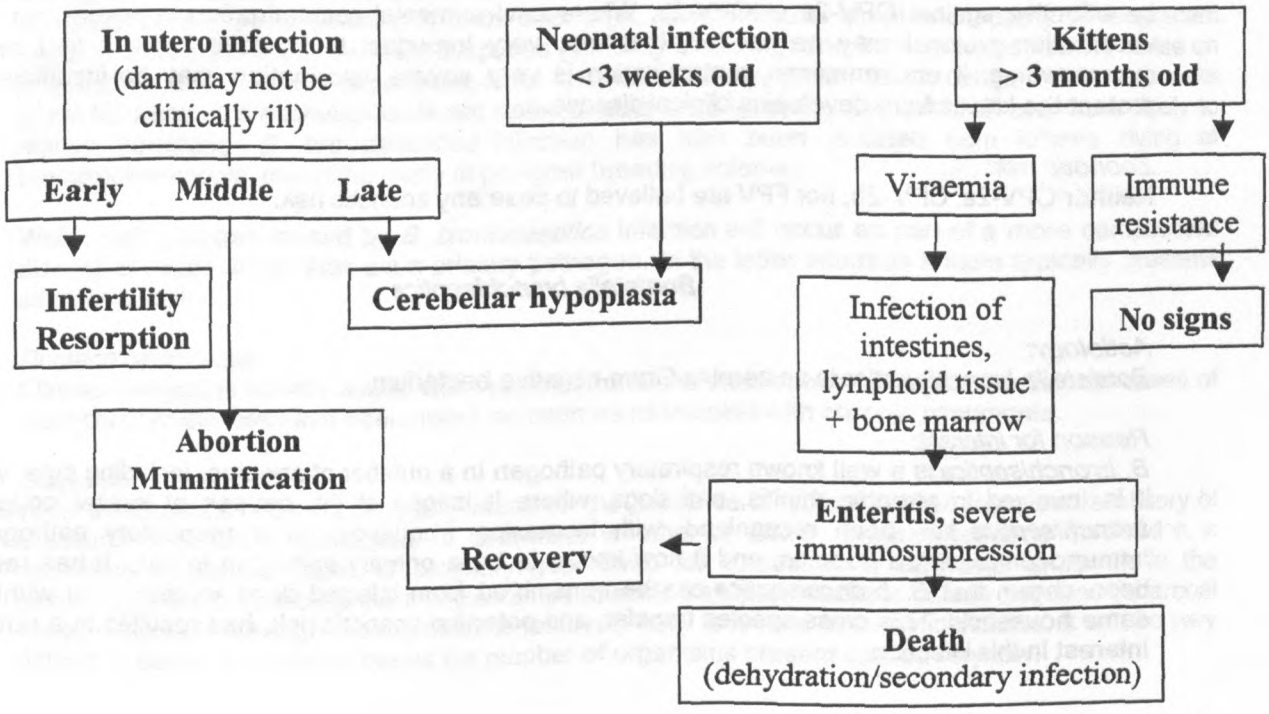
Transmission:
The principle route of infection is by direct faecal-oral contact. Clinically affected individuals shed large amounts of virus in their faeces, and will continue to do so for up to six weeks after they are clinically recovered. Parvoviruses are highly resistant to destruction. Since they can survive for up to a year in the environment, they can also be indirectly spread via environmental contamination or fomite transmission (being carried on peoples cloths, shoes, brooms, etc.).

After gaining entry into a cat the virus replicates in rapidly dividing cells, particularly the lymphoid tissue, bone marrow, and intestines and, in unborn and neonatal kittens, the central nervous system. The incubation period to the development of clinical signs is 5-9 days.

Clinical signs:
The clinical signs resulting from parvovirus infection are dependant on the age of the cat, and its immune status (see below).

In utero (when pregnant) or perinatal (around the time of birth) infections are now very rare. They are most likely to be seen when a pregnant queen is given a modified live vaccine, or in very young kittens that have not received sufficient colostrum. Early to mid-stage *in utero* infection can result in foetal death, resorption or abortion. Infection in the late-stage of gestation or in neonatal (newborn) kittens may result in kittens with profound and permanent suppression of their immune system, brain damage (cerebellar hypoplasia), or damage to their eyes (retinal abnormalities). Cerebellar hypoplasia usually becomes apparent as the kittens begin to move around the kittening box. Affected kittens are usually uncoordinated, have a wide-based stance, and shake when moving.

Infection in older kittens may be subclinical (not obvious), or may result in a range of conditions, from a self-limiting diarrhoea and panleucopenia (severely reduced white blood cell numbers and immunosuppression), through profound diarrhoea, panleucopenia, secondary bacterial infection (usually by enteric organisms), sepsis and death, to peracute death with little evidence of gastrointestinal upset. Vomiting is often bile tinged, while the diarrhoea typically contains blood and pieces of intestinal mucosa. Experimentally, CPV-2b causes disease almost indistinguishable from that caused by FPV, although it is perhaps a little milder, with lymphopenia being more significant than leucopenia.



Duration of disease:
In most cases disease is acute, with the most severe clinical signs either resulting in death or beginning to resolve within about a week. Some cases result in peracute disease, with death in less than 12 hours. In surviving cats, a full return to normality can take many weeks to months. Severe enteric damage may result in life-long defects in gut function. In the case of cerebellar hypoplasia, the cats will show clinical signs for the rest of their life.

Diagnosis:
A presumptive diagnosis of parvovirus infection is often made on the presence of clinical signs and a profound leucopenia. Other clinical findings may include mild anaemia, azotaemia (signs of dehydration), and possibly, some elevation of liver enzymes. To confirm the diagnosis it is necessary to detect virus within the faeces, or in *post mortem* material. This is usually done by ELISA test or haemagglutination of pig red blood cells. Other methods include direct visualisation (using scanning electron microscopy), or virus isolation and culture. Specialist molecular techniques are necessary to differentiate FPV from CPV.

Serology can be used to demonstrate a rising titre against parvovirus. It is necessary to detect a rising titre as a single sample could be raised because of maternally derived antibodies, vaccination, previous infection, or current infection. The second sample is usually taken two weeks after the first.

Treatment:
Treatment relies on supportive care. This includes the use of fluid therapy, broad-spectrum antibiotics (to prevent secondary bacterial infections), anti-emetics, gut-protectants, B-vitamin supplementation, provision of a warm clean environment, and good nursing care. In small kittens, fluid therapy may need to be given by the intraosseous route. Severely panleucopenic kittens may benefit from a blood transfusion. Once clinical signs have subsided, a simple, moist diet should be gradually re-introduced.

It is important to maintain strict hygiene. This is to prevent exposing the kittens to possible secondary infections, and to prevent the spread of parvovirus to other animals. Since parvoviruses are resistant to many disinfectants, hypochlorite-based disinfectants (e.g. bleach) are recommended. It is essential to remove all organic matter (e.g. faeces) prior to disinfection.

To prevent parvovirus disease all kittens should be routinely vaccinated against FPV at 8-12 weeks of age. Colostrum-deprived kittens may be vaccinated regardless of age. When vaccinating kittens of less than eight weeks of age, care should be taken to use only killed vaccines, not live attenuated vaccines. Because of significant cross-reactivity vaccines that are designed against FPV should also be effective against CPV-2a or CPV-2b. Where environmental contamination is severe, an early vaccination protocol may be needed. It is also very important to improve hygiene and reduce overcrowding. If environmental contamination is very severe, vaccination may be insufficient to protect the kittens from developing clinical disease.

Zoonotic risk:
Neither CPV-2a, CPV-2b, nor FPV are believed to pose any zoonotic risk.

Bordetella bronchiseptica

Aetiology:
Bordetella bronchiseptica is an aerobic Gram-negative bacterium.

Reason for interest:
B. bronchiseptica is a well known respiratory pathogen in a number of species, including pigs, where it is involved in atrophic rhinitis, and dogs, where it is one of the causes of kennel cough. *B. bronchiseptica* has been recognised, with increasing frequency, as a respiratory pathogen in immunocompromised humans, and it now known to be a primary pathogen in cats. It has recently been shown that *B. bronchiseptica* can be transmitted from infected dogs to cats living within the same household. This cross-species transfer, and potential zoonotic risk, has resulted in a renewed interest in this infection.

Geographical distribution:
Studies reporting infection of cats with *B. bronchiseptica* have originated mainly from the UK and USA. However, since the bacterium has world-wide distribution, it is likely to cause world-wide disease.

Signalment:
Most commonly, *B. bronchiseptica* causes disease in kittens of 6-12 week of age, especially when they are living in over-crowed, unhygienic conditions. However, it has also been isolated from 3-6 month old minimal-disease laboratory cats presenting with a dry cough and occasional sneezing.

Disease due to *B. bronchiseptica* infection rarely results from infection with this organism alone. The infection is most typically seen as one of many factors in an outbreak of cat flu. While the pathogens detected most commonly in these outbreaks are either feline calicivirus (FCV) and/or feline herpes virus (FHV-1, also called feline rhinotracheitis virus), other organisms which may be involved include feline coronavirus (FCoV), mixed bacteria; *B. bronchiseptica, Pasturella multocida* and *Mycoplasma species,* and *Chlamydia psittaci.* Most cases of cat flu involve infection with a number of these organisms, and environmental factors, such as poor ventilation, high humidity, and over-crowding, usually exacerbate the situation.

Cat flu is seen most frequently in unvaccinated cats and kittens, particularly when they are kept in large groups, either in private homes, or rescue centres. Disease is often occurs after a period of stress, such as the introduction of new animals, weaning, or travel.

Transmission:
Exposure to *B. bronchiseptica* is common. Serological surveys show ~30% of cats with no history of respiratory disease are seropositive. This compares to ~85% of cats from multi-cat households with endemic respiratory disease. In these households seroconversion typically occurs in kittens of 7-10 weeks of age. In a recent UK survey, *B. bronchiseptica* could be isolated from 0-44% of cats from a variety of sources, with cats from multi-cat households with endemic respiratory disease being most frequently infected.

The primary route of transmission is oro-nasal after exposure to infected secretions. Infection can be transmitted from clinical affected cats, recovered individuals, or carrier animals.

Clinical signs:
Infection with *B. bronchiseptica* may be subclinical, or result in acute or chronic disease. Typically, the signs of *B. bronchiseptica* infection will be those of cat flu. They will therefore include coughing, sneezing, conjunctivitis, ocular and nasal discharge, submandibular lymphadenopathy (enlargement of the lymph nodes under the jaw), dyspnoea (difficulty breathing) and increased respiratory noise on auscultation, inappetence, depression, fever and, occasionally, death. When compared to outbreaks of cat flu were *B. bronchiseptica* is not isolated, outbreaks involving this infection are more likely to feature coughing. *B. bronchiseptica* infection has also been isolated from kittens dying of bronchopneumonia, most frequently in pedigree breeding colonies.

While most disease caused by *B. bronchiseptica* infection will occur as part of a more complicated disease process, it can also act a primary pathogen. In the latter situation it more typically presents as a dry cough.

Duration of disease:
Clinical disease is usually acute, with resolution of signs after about 10 days. Occasional cases of more chronic disease have been noted, sometimes associated with chronic pneumonia.

Diagnosis:
While a diagnosis of cat flu is usually made on the presence of typical clinical signs and a history of exposure to possible pathogens, to determine whether or not *B. bronchiseptica* is involved it is necessary to send a nasal or oropharyngeal swab for culture. It is advisable to speak to the laboratory prior to collecting the samples since specific transport media is usually required (charcoal Amies medium). Although the organism is relatively easy to isolate from clinical cases, it can be very difficult to detect in carrier cases as the number of organisms present can be very low.

Pathology:
Pathological changes are generally those typical of cat flu. They usually involve moderate to severe inflammation of the conjuctivae and upper respiratory tract, including the nasal chambers, pharynx and upper airways. More severe cases may be associated with a purulent bronchopneumonia.

Treatment:
Clinical cases of Bordetellosis can usually be successfully treated with tetracycline (10mg/kg orally q8-12 hours), doxycycline (10mg/kg orally q24 hours) or fluoroquinolones. Tetracycline should not be used in kittens as it will discolour the teeth. To the author's knowledge, this has not been shown to occur with doxycycline. However, the drug is not recommended for use in kittens by the manufacturer. Doxycycline treatment of carrier cats does not prevent *B. bronchiseptica* shedding. Since *B. bronchiseptica* infection typically occurs as part of more generalised cat flu, other aspects of treatment usually include symptomatic therapies and good nursing care.

To try to reduce the risk of further outbreaks of respiratory disease it is usually advisable to try to address infectious as well as non-infectious causes. This may require instigating a suitable vaccination and/or isolation programme, treating with suitable antibacterials, improving nutrition, ventilation and hygiene, and reducing over-crowding.

A number of *B. bronchiseptica* vaccines are available in different countries; including a modified live intranasal vaccine in the UK.

Zoonotic risk:
Interspecies transfer of *B. bronchiseptica* has been shown to occur between laboratory animals, between dogs and cats, and possibly from a rabbit to its human owner (an elderly woman). It is therefore possible, but not proven, that cats and/or dogs, could pose a potential zoonotic risk, especially to immunocompromised individuals.

Feline spongiform encephalopathy (FSE)

Aetiology:
Feline spongiform encephalopathy (FSE) is one of a group of naturally occurring transmissible spongiform encephalopathies (TSEs). The TSE agents are unlike any other micro-organisms. All TSE diseases are characterised by the accumulation of an abnormal form of a host-coded protein, the prion-protein (PrP). PrP is found in all animals; it is a cell surface glycoprotein of unknown significance. However, while the PrP isolated from normal individuals (PrPc) and the PrP isolated from TSE infected individuals (PrP-res) have the same amino acid sequence and secondary structure, PrPc is totally degraded by proteinase K, while PrP-res resists digestion. Once present, PrP-res is believed to induce additional copies of itself by interacting with normal PrPc. In doing this PrP-res acts as an infectious agent. Once the host-coded PrPc has been transformed into PrP-res it accumulates in fibrils (SAF), and this leads to disease.

Reason for interest:
TSE diseases occur in many mammalian species, including man. They include Scrapie in sheep and goats, bovine spongiform encephalopathy (BSE) in cattle, chronic wasting disease (CWD) of Deer and Elk, transmissible mink encephalopathy (TME) in mink, and Creutzfeldt-Jakob disease (CJD), Gerstmann-Sträussler-Scheinker disease (GSS), and kuru in humans. Experimentally, TSEs can be transmitted to an even wider range of species, including rodents and non-human primates. While the wide-spread interest in TSEs developed only recently, mainly associated with the BSE epidemic and the recognition of variant CJD (variant CJD), this type of disease is far from new. Historical records show that Scrapie was first recognised almost three hundred years ago. FSE was first recognised in 1990.

Geographical distribution:
TSEs have been seen in many countries throughout the world. However, while Scrapie and human TSEs have a wide-spread distribution, BSE has been seen mainly in Europe, particularly in the UK. The situation with FSE is similar to BSE, with the majority of cases being seen in the UK.

Transmission:
The agent responsible for FSE is believed to be the same as that for BSE. The BSE agent is believed to have entered the UK cat population in contaminated pet food. BSE was first reported in 1987. It is believed to have resulted from the inclusion of scrapie-infected sheep carcasses, in the form of meat and bonemeal, into feedstuffs for cattle. A change in the rendering process had enabled the TSE agent to survive the processing procedures. Transmitting the scrapie agent through cattle is believed to have resulted in a change to its pathogenicity, making it more infectious to cattle (and cats). Cattle succumbing to BSE were then included into the meat and bonemeal, thereby amplifying the transmission and spreading the infection. The feeding of meat and bonemeal to ruminants was then banned in 1988. Also in 1988, the Pet Food Manufacturers Association (PFMA), recommended to its members that 'specified bovine offal' (SBO) be banned from inclusion in pet food. This later became law. Subsequent changes to the handling of offal material should have removed any further risk of cats being exposed to the BSE agent in commercial pet food.

Consistent with the hypothesis that FSE is caused by the BSE agent is the temporal distribution of FSE cases. Since its recognition in 1990, ~90 cases of FSE have been confirmed. The majority of these were seen between 1990 and 1994. Since that time there has been a general decline in the number of cases. It shows that after a time interval representing the incubation period of the disease, the removal of SBO from the diet of cats in the UK resulted in a marked reduction in the incidence of FSE. Also, a retrospective study of brain sections from cats with neurological disease revealed no cases of FSE prior to 1990. However, since very few domestic cats are subject to routine *post mortem* examination it is likely that the total number of FSE cases has been underestimated.

While the natural route of FSE transmission is unclear, it is believed to result from ingestion. While maternal transmission may occur in some species, there is no evidence of it occurring in cats. TSE diseases are exceptional as they are not only infectious, but in some cases, they can also be transmitted genetically. However, while this is true of certain human TSEs (e.g. GSS) and, to some extent, Scrapie in sheep, it does not appear to be the case for BSE or FSE.

Signalment:
Consistent with a food-related infection FSE shows no breed predisposition, and cats from all types of household have been affected. While FSE has been seen in both sexes, it has been seen more frequently in males. The mean age at onset is approximately 5-7 years. However, a wide age range of cats have been affected; ranging from 2-12 years of age.

Clinical signs:
FSE is characterized by a long asymptomatic incubation period followed by an insidious onset of clinical signs. These consist of progressive behavioural and motor disturbances. Cases may present with progressive hind limb ataxia, increased aggression or affection, hyperaesthesia to touch, sound and/or light, altered grooming patterns, increased salivation, dilated pupils with an unusual staring expression, polyphagia and/or polydipsia, abnormal head posture, jaw chattering, aberrant defaecation/urination, muscle fasiculations, or an inability to retract their claws. Behavioural changes are usually noted first, followed by progressive locomotor dysfunction. The cats tend to show ataxia, with dysmetria or hypermetria, which often leads to an erratic crouching gait. They also show an inability to judge distances.

Duration of disease:
The disease is generally progressive, warranting euthanasia within 8-12 weeks of the onset of clinical signs.

Diagnosis:
Pre-mortem diagnosis is rarely possible. While clinical signs may be suggestive of FSE, and non-specific tests, like electroencephalography (EEG) or magnetic resonance imaging (MRI) may indicate the presence of diffuse CNS disease, specific tests are generally lacking. Diagnosis of FSE is usually made by histopathological examination of the brain (formalin fixed tissue), and the ultrastructural detection of SAF in brain extracts (fresh frozen brain or spinal cord). After euthanasia, any case suspected of having FSE should have a full *post mortem* examination, which should be performed by trained veterinary pathologist. If the diagnosis is confirmed, the veterinary surgeon should contact their local Divisional Veterinary Manager.

Pathological changes are confined to the CNS and consist of variable degrees of vacuolation of the neuronal parenchyma and an astrocytic response.

Treatment:
There is no effective treatment.

Zoonotic risk:
Although it is generally difficult to transmit a TSE agent from one species to another by mouth, BSE appears to have been transmitted naturally, not only to cats, captive exotic felids, and captive exotic ungulates, but also to humans (as variant CJD). Thankfully, with the introduction of strict laws regulating the slaughter and rendering of ruminants in the UK, and the overall decline in the incidence of BSE, the possibility of the BSE agent continuing to be included in the food chain is extremely small. However, because the incubation period is long and variable we are likely to continue to see new cases of variant CJD for a few years yet to come.

It is very unlikely that cats present a zoonotic risk. This is because, not only is the disease now extremely rare, it was never very common, and the likelihood of FSE-infected brain or spinal cord entering the human food chain is almost non-existent. While there has been one case of human CJD and FSE occurring within the same household, the strain of TSE with which both individuals were affected appears to have been a variant more typically associated with spontaneous CJD, not BSE. The method of transmission in this case is not known.

Borna disease virus (BDV)

Aetiology:
Borna disease virus (BDV) is a neurotropic (likes to live in the brain of its hosts) RNA virus.

Reason for interest:
Classical Borna disease (BD) is seen predominantly in horses and sheep in endemic areas of Germany and Switzerland. However, while the disease was initially thought to be limited to these species and this location, it is now known that natural infections can also be seen in cats, ostriches, and occasionally, rabbits, cattle, goats, deer, and dogs. Experimentally, BD virus (BDV) can be transmitted to a very wide variety of species, including birds, rodents and monkeys. Far from being a regional infection, serological evidence has documented BDV in central and northern Europe, North America, the UK, Japan, Iran, Israel and Australia. The presence of a higher prevalence of BDV infection in humans with neurologic or psychiatric disorders has suggested that the infection may have zoonotic potential.

Geographical distribution:
BD in cats is also known as "staggering disease". From serological surveys or surveys looking for BDV RNA within peripheral blood samples, we know that BDV infection is often asymptomatic; ~6% of healthy cats in the UK are seropositive. The prevalence of seropositive cats appears to increase with age. However, while BDV may be detected in many normal cats, BDV RNA or antibodies against BDV are seen most frequently in cats with neurological disease. While fatal BD is seen most commonly as a rare isolated event, it can occasionally be seen in large outbreaks, where as many as 30-40 cases may be seen in a week. While most documented cases of feline BD have originated from northern and central Europe, probable cases of BD have also been seen in other countries. Given the difficulty in making a *pre-mortem* diagnosis, and the low index of suspicion, it is likely that BD is under-diagnosed.

Signalment:
Natural BD, has been reported in over 100 cats. It is seen most frequently in male cats, with no particular breed predisposition. While a wide age range of cats may be affected (from five months to 11 years), young adults appear to be most at risk. Affected cats have usually been allowed to roam outdoors, particularly in rural or woodland areas.

Transmission:
The natural reservoir host of BDV is not known. However, since the virus can infect so many different species, a single reservoir may not be required. In feline BD, hunting mice appears to be a risk factor. Most natural infections are believed to occur via saliva or nasal secretions from clinically affected animals or apparently normal virus carriers.

It is currently not clear whether there is a single biotype of BDV that can infect and cause disease in a wide range of species, or whether there are species-specific biotypes. Either way, BDV appears to be a ubiquitous virus that is very well adapted to its various host species. In most cases, infection causes little or no sign of disease. It is only when a host is particularly susceptible, or mounts an abnormal response to the virus, that clinical signs develop.

Clinical signs:
"Staggering disease" is characterized by behavioural and motor disturbances resulting from meningo-encephalomyelitis. In experimental infections, clinical signs included protrusion of the third eyelid, behavioural changes, circling, ataxia, and tremors. Natural infections may present with progressive hind limb ataxia, often with hypermetria and a crouching gait, behavioural changes, including increased timidity, aggression or affection towards the owner, fever, hypersensitivity to light and/or sound, unusual staring expression, loss of appetite (occasionally polyphagia), apparent pain over the sacrum, altered grooming patterns, seizures, increased salivation, an inability to retract their claws, muscle fasiculations, or constipation.

Duration of disease:
Disease is usually progressive, warranting euthanasia within one week to six months from the onset of clinical signs. In naturally infected cats, once clinical signs develop, mortality rates are usually high. Animals that survive the initial episode may remain chronically infected, and may experience recurrent episodes of disease.

Diagnosis:
Pre-mortem diagnosis can be difficult. In most cases typical clinical signs, in a cat from an endemic area, will result in a presumptive diagnosis of BD. Detection of serum antibodies is not reliable. While raised serum antibodies may be present in some cats with BD (~40%), other affected cats may be antibody negative. Although clinical signs of BD tend to develop at the same time as BDV RNA can be detected within the peripheral white blood cells, the detection of BDV RNA within peripheral blood does not necessarily reflect the extent of the viral load in the CNS. Routine serum biochemistry and haematology are generally unremarkable, although some cats may show a leucopenia (reduced numbers of white blood cells), and mild elevations in glucose and liver enzyme levels. CSF analysis may show a leucocytosis (increased number of white blood cells), with mononuclear cells predominating, and protein levels may be increased.

Pathologically, BD results from a non-suppurative meningo-encephalomyelitis, which is usually particularly evident in the grey matter of the cerebral hemispheres, the limbic system and the brainstem.

Treatment:
There is no specific treatment for BD. Supportive care and corticosteroids may help in some cases. Prednisolone may be given, at 1-2 mg/kg PO q24 hours, until clinical signs regress, then reduced gradually over several weeks or months.

Zoonotic risk:
It is currently unclear what role BDV may play in the induction of human disease. Antibodies against BDV, viral proteins and RNA have been found in humans in Europe, North America and Asia. A higher prevalence of infection is seen in patients with neurologic or psychiatric disorders, particularly schizophrenia and uni- or bipolar disorders. However, since the virus has also been detected in clinically normal patients, a role for BDV in the development of these complex psychiatric disorders has still to be proven.

The presence of BDV infection in many domestic species and evidence of cross-species transfer, raise the possibility of zoonotic spread. However, while animal species may pose a potential risk to humans, finding BDV RNA in blood from normal human blood donors suggests that humans may perhaps be as much at risk from horizontal spread between humans. Considerably more investigation needs to be performed before the zoonotic potential of BDV can be determined.

Bartonella henselae

Aetiology:
Bartonella hensalae is a small, curved, Gram-negative, facultative intracellular bacterium. It is closely related to *B. clarridgeiae.* Both of these organisms can be found in the blood of asymptomatic cats.

Reason for interest:
While *B. hensalae* and *B. clarridgeiae* are currently believed to cause little or no disease in cats (see below), it is now known that in humans *B. hensalae* is the major cause of cat scratch disease (CSD), bacillary angiomatosis (BA), and visceral bacillary peliosis (BP). *B. clarridgeiae* has also been implicated in CSD.

Geographical distribution:
Serology has shown that *B. hensalae* and, to a lesser extent, *B. clarridgeiae* are common infections in cats throughout the USA. The presence of *B. hensalae* has also been confirmed in the UK, France, Portugal, the Netherlands, Australia, the Hawaiian islands, Japan, Israel, and Egypt. It is presumably found throughout most temperate regions of the world. A higher prevalence of seropositive individuals is generally found in older cats, especially those coming from warm, humid, flea-infested areas, or feral populations.

Signalment:
Most cats are infected with *B. hensalae* when they are kittens; this probably occurs when they are first bitten by fleas. Cats from households with a significant flea problem are therefore more likely to become infected. Most *B. hensalae* infected cats are asymptomatic. To date, only mild disease has been confirmed in cats experimentally (see below).

Transmission:
B. hensalae is an intra-erythrocytic (lives in red blood cells) bacterium. Once infected, cats can remain bacteraemic (have bacteria circulating in their blood) for many months, and may experience relapsing bacteraemia. While the infection can be transmitted from cat-to-cat in blood transfusions, the natural route of transmission appears to be via fleas. Whether the fleas act as mechanical or biological vectors is currently unclear. While very few fleas are needed for transmission to occur between cats, transmission does not occur in the absence of fleas.

Clinical signs:
In the vast majority of cats, infection with *B. hensalae* is subclinical. If it does cause disease, it is most likely to occur in chronically infected cats, associated with episodes of stress, or in conjunction with other diseases.

Experimentally, infection with *B. hensalae* can result in a self-limiting febrile illness of 2-3 days duration. Some cases have also shown anorexia, generalised peripheral lymphadenopathy, and inflammatory lesions in multiple organs. Other cases have demonstrated mild neurological dysfunction, with lethargy, staring expression, disorientation, unresponsiveness, and ataxia.

While not yet proven, there are a number of feline diseases for which *B. hensalae* infection is being investigated as a potential cause. These include persistent focal or generalised lymphadenopathy, peliosis hepatis, chronic relapsing uveitis, and cataract formation. However, because so many chronically bacteraemia cats are healthy, it will be difficult to establish a causal relationship between bacteraemia and these specific disease presentations.

Diagnosis:
While serology may provide useful epidemiological information, it is of limited clinical use as its correlation with a positive blood culture is poor. While high titres do tend to correlate fairly well with a positive culture result, low titres may occur in culture-negative cats and, occasionally, culture-positive cats may be antibody negative. Blood culture needs to be performed by a specialist laboratory. *B. hensalae* may also be detected by specialist staining of peripheral blood smears.

Most cats show no pathological changes. Experimentally, cats have shown lymphoid hyperplasia, and inflammatory foci within the lymph nodes, spleen and liver.

Treatment:
Unfortunately, the efficacy of antibiotics to remove *B. hensalae* from cats has not been clearly established. Several antibiotics that are effective in humans are ineffective in cats, even after prolonged administration. Also, different studies have generated contradictory results. At present, it is suggested that enrofloxacin, doxcycline, and rifampin, can be used either alone or perhaps in combination. Treatment should be given for 2-4 weeks. Repeat cultures should be taken 2-4 weeks after finishing the treatment.

Zoonotic risk:
CSD occurs word-wide. It is seen most commonly in children and adolescents, most frequently males. There is a seasonal incidence, with 60% of cases occurring between September and January. Occasionally, multiple cases may be seen within one household. Since the estimated incidence in the USA is nine cases per 100,000 people, it represents a very significant problem, both medically, and financially. CSD is a significant occupational hazard for the veterinary profession.

Initial suspicions that cats played a role in transmitting CSD came from serological studies. These showed that 90% of CSD cases had contact with a cat, and 80% of CSD cases had had a cat bite or scratch. At present it is not known whether the organism is passed by cats to humans by direct contact (e.g. bites or scratches), or indirectly (e.g. by fleas).

The vast majority of CSD cases are benign and self-limiting (> 85% cases). In these cases there is typically a sub-acute regional lymphadenopathy, a papular skin lesion at the site of inoculation, a low grade fever, malaise, and myalgia (muscle pain). Very rarely, atypical disease may occur. This may take the form of encephalopathy (inflammation of the brain), an oculo-glandular syndrome (after inoculation into the eye), arthralgia/arthritis, hepatitis (inflammation of the liver), or pneumonia. Even in these cases, the disease is rarely fatal.

In immunocompromised individuals, particularly those suffering from AIDS, *B. hensalae* infection may result in the development of either bacillary angiomatosis (BA), which consists of vasoproliferative blood-filled cysts in the skin, or bacillary peliosis (BP) which consists of vasoproliferative blood-filled cysts in internal organs, especially the liver.

Very rarely, *B. hensalae* infection can cause in a relapsing bacteraemia, which is associated with fever, malaise, fatigue, and weight loss.

Since fleas appear to play a major role in the transmission of *B. hensalae* between cats, and possibly from cat-to-humans, it is advised that cats owned by immunocompromised individuals should, where possible, be checked for the presence of *B. hensalae*, and then maintained under a strict flea-control regime. Also, since CSD is frequently associated with exposure to kittens, it is advised that immunocompromised people should keep adult rather than young cats. It is advised that they do not play roughly with then, and that they wash their hands after handling them. In the longer term, attempts are being made to develop a vaccine to protect cats against infection with *B. hensalae.*

Infectious Disease Cases

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Case 1. Emma

Eight-week old female kitten from the Dog and Cat Home. One of 4 kittens born in the rescues centre. One kitten was found dead in its cage three days ago, the other 3 kittens became ill the following day with vomiting and diarrhoea. The other 2 kittens died last night. This kitten has severe, very watery, very malodorous, blood stained diarrhoea. She is markedly dehydrated and very weak. Abdominal palpation reveals abdominal pain and gas/fluid filled intestinal loops.

a) List the most likely causes of severe diarrhoea in a kitten of this age.

A small sample of blood was collected:
It revealed moderate anaemia (PCV 18%), moderate platelet numbers, and a total white cell count of 2.1 $x10^9$/l (neuts. = 44 %, lymphs. = 56 %, eos. = 10 %).

b) What is/are the most significant finding(s)?

c) What are the most likely differential diagnoses?

d) How would you try to confirm a diagnosis?

e) How would you try to treat this kitten?

Case 2. Diesel

14-week-old male Ragdoll kitten. Fully vaccinated. From breeder 2 weeks ago. No access outside. Occasional cough from 1 week ago, then rapid deterioration, severe dyspnoea and mouth breathing. HR 200 bpm, no gallop or murmurs. Pulse quality good. RR 48 bpm, marked inspiratory and expiratory dyspnoea, chest dull to percussion ventrally, reduced thoracic compression ventrally, marked increase in respiratory noise, especially on expiration.

Haematology revealed neutrophilia with a left shift, occasional toxic mature neutrophils, and occasional activated monocytes and macrothrombocytes. Serum biochemistry revealed moderate hypoproteinaemia. Thoracic radiographs reveal extensive and severe changes, with a generalized patchy bronchio-interstitial pattern, especially affecting the right cranial lobe, with apparent pleural fluid on the right side cranially and tracheal dilation at the bifurcation. Right cranial thoracocentesis yielded only a very small amount of serosanginous sticky fluid. It was found to an exudate containing non-toxic neutrophils, mesothelial cells and occasional monocytes. It was sterile on culture.

a) What are the most likely differentials in this case?

b) How would you try to manage this case?

Unfortunately, Diesel deteriorated further, developed a pneumomediastinum, then died of respiratory arrest. A post mortem examination revealed severe, multifocal, necrotizing bronchopneumonia. The presence of an intranuclear inclusion-forming virus was demonstrated, which had morphology typical of Feline Herpes Virus (FHV-1). Bacterial culture of the lungs grew *Bordetella bronchiseptica*.

c) Briefly, consider how Diesel may have become infected, what underlying factors may have contributed to his ill heath, and what advice you would give to his breeder to try to reduce the risk of this happening to other kittens.

Case 3. Smudge

5-year-old FN DSH. Indoor/outdoor cat. Hunter. Previous history of cat fight abscesses. Presented with tacypnoea (60 breaths per minute), which appears inspiratory and expiratory, and an occasional soft cough. He owner reports that Smudge has been rather quite and inactive for the last week or so.

Physical examination reveals a number of small ulcerated nodules, mainly on her face and limbs, and harsh respiratory noises on thoracic auscultation.

Thoracic radiographs were taken (and will be shown).

a) Define the problem list and list the differential diagnoses.

b) What are the most likely differentials for this cat?

c) Detail your diagnostic plan.

Case 4. Guy

A 9 month old, MN, Persian cat. No outside access, fully vaccinated (including FeLV). Other than 1 week of diarrhoea shortly after moving into his new home at 12 weeks old the kitten had no previous medical problems. One other cat (7 year old MN DSH).

Presented as an emergency in acute respiratory distress. In the 48 hours prior to presentation he had been quiet, with a reduced appetite. A progressive increase in respiratory rate and mild cough had first been noted 7 days previously.

Physical examination revealed tachypnoea (RR 72 bpm), inspiratory dyspnoea with marked abdominal effort, mild cyanosis, reduced thoracic compression, ventrally dull percussion, cranioventrally reduced lung sounds, HR 200 bpm (no murmurs or arrhythmias), pulse quality good, no pulse deficits, temperature normal.

a) Define your major problem list for this case

b) Broadly, list your differential diagnoses, then indicate which are most likely in this case?

The presence of pleural fluid was briefly confirmed by ultrasound examination prior to performing thoracocentesis. 65ml of viscous straw coloured fluid was aspirated*. Thoracic radiographs revealed a small amount of pleural fluid and no evidence of any abnormal masses. Abdominal ultrasound examination and radiography revealed no abnormalities.

*The thoracic fluid had a specific gravity of 1.045, total protein 82 g/l, with a nucleated cell count of 1.2×10^9/l. Cytological examination revealed a background of proteinaceous material with mature and degenerate polymorphs (mostly neutrophils) and occasional macrophages. No bacteria were seen.
Haematology revealed a mild mature neutrophilia (15.0×10^9/l; ref 2.5-12.8) and a moderate lymphopenia (1.21×10^9/l; ref 1.5-7.0). Serum biochemistry revealed a moderate elevation in total protein (96.7 g/l; ref 69-79), hypoalbuminaemia (21.9 g/l; ref 28-39), hyperglobinaemia (74.8 g/l; ref 23-50) and an albumin:globulin ratio 0.29.

c) What are the most likely differential diagnoses?

d) What further investigations would you like to undertake?

e) Suggest any possible treatment options for FIP.

Case 5. Huey

8 y MN DSH. Indoor / outdoor.
2 week of dyspnoea. Referring vet performed thoracocentesis, removed 70 ml of sticky blood stained fluid and diagnosed pyothorax. Huey was given 4 days of oral antibiotics and his chest was drained daily. There was little improvement.

a) What would you do now?

A unilateral chest drain was placed, and the antibiotics were changed as indicated by culture and sensitivity (amoxicillin-clavulinate and metronidazole). The drain was removed after 10 days but the fluid recurred.

b) What would you do now?

Huey was referred. On clinical examination he was found to be thin, his chest was bilaterally dull to percussion, with increased lung sounds dorsally. He appeared to have lumbar pain and occasionally appeared to be rather twitchy.

Haematology revealed a mild non-regenerative anaemia, and lymphopenia. Serum biochemistry revealed significant hypoalbuminaemia. Tests were negative for FeLV and FIV. Serology for Toxoplasmosis revealed an IgG titre of 1:1024 and an IgM titre of 1:1024. Thoracic radiographs reveal bilateral pleural fluid, with apparently collapsed left lung lobes, and a general alveolar pattern. Thoracic ultrasonography revealed fluid in pockets, but no masses. The fluid was aspirated and found to be serosanguinous and turbid. It was sterile on culture, but was seen to contain many neoplastic lymphocytes.

c) How do you interpret these findings?

d) How would you treat this case?

Case 6. Sampson

Ex-stray, ~8 years old, male neutered, Persian.
Presented by his new owners because he is not eating very well and has diarrhea. On clinical examination he is found to be very thin (body condition score ~3 out of 9). His coat is in very poor condition. He has evidence of chronic bilateral conjunctivitis with moderate amounts of ocular discharge. Halitosis is present and appears to be associated with severe gingivitis/stomatitis.

His new owner's are already very fond of Sampson and they want to keep him. They ask you to do what you can to make him healthy.

a) What preliminary test would you like to run?

Results from an in-house ELISA find Sampson to be FIV positive and FeLV negative.

b) How do you interpret these results and what do you advise Sampson's owner?

c) Sampson's owners still want to keep him. Define your diagnostic plan.

Results from further investigations show Sampson has mild non-regenerative anaemia, a high white blood cell count (moderate mature neutrophilia, monocytosis and eosinophilia), *Chlamydophila felis* is detected from an eye swab, *Giardia* spp. are detected in a faecal sample and IBD is found when endoscopy was performed following apparently successful treatment for giardiasis.

d) Discuss the significance of each of these findings.

e) Describe a suitable management and treatment plan for Sampson.

Follow-up: Treatment was very successful, Sampson gained weight but still had occasional diarrhea. One year later, while still on an exclusion diet, and receiving prednisolone (1mg/kg PO q48h) and metronidazole (10mg/kg PO q24h), he again developed severe diarrhea.

f) What investigations would you undertake at this time?

Lymphocytic lymphosarcoma of the SI was diagnosed by endoscopy.

g) How would you now treat this case?

Answers for Infectious Disease Questions

Case 1. Emma

a) FPV, FeLV, Coccidia, Campylobacter, Salmonella, Giardia, Cryptosporidium, FCoV, *Pentotricomonas foetus*, FIV, Toxoplasmosis, etc.

b) Panleucopenia, neuts 0.9 $x10^9$/ml, lymphs 1.2 $x10^9$/ml, eos 0.2 $x10^9$/ml.

c) FPV, FeLV, FIV, Salmonella, Toxoplasmosis.

d) Blood sample for FPV antibody, FeLV antigen/virus, FIV antibody, Toxoplasmosis antibody. FPV: virus isolation from faeces, oropharyngeal swabs in transport media, or post mortem material, or commercial kits for the detection of antigen in faeces. Salmonella from faecal culture.

e) How would you try to treat this kitten?
Treatment relies on supportive care: intensive fluid therapy (may need intra-trochanteric, ie intra-bone marrow fluids), broad-spectrum antibiotics, anti-emetics, gut-protectants, B-vitamin supplementation, provision of a warm clean environment, and good nursing care.
If cost is not an issue parenteral feline interferon omega can be very helpful (rFeIFN• - Virbagen). Licensed to treat CPV using 2.5 M IU/kg IV q24h, for 3 consecutive days. In a study of 92 dogs, death occurred four times less in the treated dogs than the controls over; over 9 days.
If available, severely panleucopenia kittens may benefit from a blood transfusion. Once clinical signs have subsided, a simple, moist diet should be gradually re-introduced.

Case 2. Diesel

a) Differentials for pulmonary infiltration: bacterial pneumonia (*B. bronchiseptica*, Mycobacteria [tubercule group, *M. avium*, or opportunistics], Pasturella, mixed anaerobes, Actinomycetes, Nocardia, Mycoplasia, other), viral pneumonia (Pox, FHV, FCoV), parasitic pneumonia (lung worm [*A. abstrusus*], Toxoplasmosis, larval migration), fungal pneumonia (Aspergillus, other), lipid pneumonia, foreign body pneumonia, inhalation pneumonia, neoplasia (primary pulmonary neoplasia, lymphoma, or metastatic disease), pulmonary oedema (cardiac or non-cardiac [near drowning, strangulation, head injury]), infiltration with eosinophils (asthma, lung worm), chronic sterile bronchopneumonia, idiopathic pulmonary fibrosis, haemorrhage (bleeding diathesis, warfarin poisoning), pulmonary contusions.
Also consider possible causes of pleural fluid, especially FIP.

Most likely differentials include viral pneumonia (FHV, FCoV, possibly FCV), acute Bordetellosis, possibly Mycoplasma pneumonia.

b) Supportive care; oxygen therapy, iv antibiotics (enrofloxacin, amoxicillin-clavulinate and metronidazole), terbutaline, inhaled salbutamol and steroids.

c) He was vaccinated against FHV-1 so suspect a vaccine failure or breakdown. This may have resulted from heavy environmental contamination which, if combined with strong MDA protection, could have resulted in vaccine failure when first vaccinated at 8 weeks of age. This could then have been followed by infection either prior to second vaccination, or be related to inadequate protection from the second vaccination. The Bordetella is also most likely to have come from the breeding household. Diesel may have had a congenital defect in his immune system that predisposed him to disease.
The breeder needs to improve hygiene standards, treat any animals that may be Bordetella carriers (it turned out that the dog had chronic Kennel Cough), reduce stocking density, improve airflow, instigate an early vaccination policy and, preferably, stop breeding for a few months.

Case 3. Smudge

a) Multiple skin nodules: DDx eosinophilic complex, mast cell tumours, metastatic neoplasia, mycobacterial infection (tuberculosis, leprosy, opportunistics), pox virus infection, flea or insect bite allergy, fungal infection, etc.

Pulmonary infiltration: bacterial pneumonia (*B. bronchiseptica*, Mycobacteria [tubercule group, *M. avium*, or opportunistics], Pasturella, mixed anaerobes, Actinomycetes, Nocardia, Mycoplasia, other), viral pneumonia (Pox, FHV, FCoV), parasitic pneumonia (lung worm [*A. abstrusus*], Toxoplasmosis, larval migration), fungal pneumonia (Aspergillus, other), lipid pneumonia, foreign body pneumonia, inhalation pneumonia, neoplasia (primary pulmonary neoplasia, lymphoma, or metastatic disease), pulmonary oedema (cardiac or non-cardiac [near drowning, strangulation, head injury]), infiltration with eosinophils (asthma, lung worm), chronic sterile bronchopneumonia, idiopathic pulmonary fibrosis, haemorrhage (bleeding diathesis, warfarin poisoning), pulmonary contusions.

b) Mycobacterial infection, Pox virus, cutaneous and pulmonary neoplasia (particularly mast cell neoplasia, lymphoma, or metastatic carcinoma), hypereosinophilic skin lesions, asthma, lungworm, unrelated bacterial pneumonia.

c) Bloods for haematology, serum biochemistry (including calcium), serology for FeLV, FIV and Toxoplasmosis. Bronchioalveolar lavage (BAL) for cytology and culture - request specific bacteria, plus fungi, stain smear for ZN bacteria, request Mycobacterial culture. Faecal analysis for lung worm (or test treat with fenbedazole). Biopsy skin masses; histopathology, culture, store a section for possible later Mycobacterial culture.

Results: ZN positive pyogranulomatous skin lesions, macrophages and neutrophils in BAL fluid. Serum calcium concentration was raised. Skin mass cultured *M. microti*-like (ie tuberculosis).

Good response to treatment with enrofloxacin, azithromycin and rifampicin (all 3 for 2 months, then the first 2 for a further 4 months).

Case 4. Guy

a) Define your major problem list for this case?

1. Dyspnoea
   Reduced thoracic compression, dull thoracic percussion, reduced lung sounds cranioventrally, tachypnoea
2. Marked abdominal respiratory effort

b) Differential diagnoses:

Dyspnoea -
Non-respiratory causes - Congestive heart failure, haemoglobin disorders (anaemia, methaemoglobinaemia), metabolic (acidaemia, severe hypokalaemia in cats), pain, severe CNS disease.
Upper airway disorders - Nasal cavity (eg obstruction), pharynx/larynx (eg pharyngeal polyp), cervical trachea (eg trauma/foreign body).
Lower airway disorders - Bronchial disease (allergic/infectious/parasitic), extraluminal compression (lymphadenopathy/ neoplasia).
Pulmonary parenchymal disorders - Oedema (cardiogenic/noncardiogenic), pneumonia (infectious/parasitic/inhalational), neoplasia (primary, metastatic, or lymphoma), allergy (asthma, parasitic), embolism (disseminated intravascular coagulation), trauma/bleeding disorders.
Pleural/body wall disorders - Pneumothorax, pleural fluid (blood, transudate, exudates, chyle, pus), congenital (pectus excavatum), thoracic wall trauma, thoracic wall neoplasia, thoracic wall paralysis, diaphragmatic hernia (congenital or acquired).
Mediastinal disorders - Infection, trauma (including pneumomediastinum), neoplasia (eg lymphoma).
Peritoneal cavity disorders - Organomegaly/obesity, peritoneal fluid.

Marked abdominal respiratory effort - Diaphragmatic hernia, diaphragmatic paralysis, pleural space disease, pneumothorax, pleural fluid (eg blood, transudate, exudates, chyle, pus), decreased pulmonary compliance (pulmonary fibrosis), severe upper airway obstruction.

The most likely differentials at this stage were pleural fluid (pus, exudates/transudate, blood, chyle), diaphragmatic hernia (congenital or traumatic) or thymic lymphoma.

c) What are the most likely differential diagnoses?

The pleural fluid is a non-septic exudate. Wet FIP, possibly heart failure, or thoracic neoplasia (eg thymic lymphoma), possibly consider severe pancreatitis.

d) What further investigations would you like to undertake?
Pleural fluid culture (sterile), FCoV antibody titre (>1280) alpha-1 glycoprotein levels (1900ug/ml), echocardiography (no abnormalities detected) and repeated thoracic ultrasound examination (no abnormalities detected).

e) Prednisolone (2mg/kg PO q 24 hours), rFelFN (1 MU/kg injected SQ by the owner every second day). Thoracocentesis had alleviated the acute respiratory distress and the kitten was sent home so that stress, a known contributing factor in FIP, would be kept to a minimum. The owner was shown how to count the respiratory rate and asked to seek veterinary attention if the rate was greater than 50 bpm.

Prognosis for FIP is grave, and most cats will die within 2 months of the onset of clinical signs. Recently, Ishida et al (2002) used a combination of rFelFN and glucocorticoids in naturally occurring cases of FIP and achieved complete remission (survival > 2 years) in 4/12 cats and partial remission (2 to 5 months) in another 4/12 cats.

Guy - kitten's appetite and energy levels improved and his respiratory rate remained stable at ~30bpm. After 3 weeks prednisolone was reduced to 1mg/kg PO q24h and then slowly decreased to 0.5mg/kg q48h. After 4 weeks the rFelFN was reduced to 1MU/kg SQ once a week. This treatment has been continued for five months and the cat is clinically normal at present (~12 months after diagnosis).

Case 5. Huey

a) Repeat culture and sensitivity, and cytology. Place indwelling chest drain(s).
b) As above, plus look for underlying conditions, eg use thoracic radiography and/or ultrasound examination to look for tumours, abscesses, foreign bodies. Assess FeLV, and FIV status.
c) Mild non-regenerative anaemia and lymphopenia - probably from repeated thoracic drainage and because of chronic disease. Hypoalbuminaemia - probably from repeated thoracic drainage. Toxoplasmosis titres - serological evidence of active disease. Thoracic changes consistent with pulmonary lymphosarcoma (LSA) and/or pulmonary Toxoplasmosis. CNS/spinal toxoplasmosis and/or LSA could account for the lumbar pain and twitchiness. The latter could also have been caused as a side effect of metronidazole treatment.
d) COAP chemo. Protocol and clindamycin (75mg po q12h)
After 1 month: thoracic radiographs revealed no abnormalities.
Toxo IgG 1:256, IgM 1:64
After 2 months: Huey was getting very resentful of intervention, and vomiting regularly. All medication was stopped.
Still well after 3 years!

Case 6. Sampson

Interpretation of results:
FIV - real result, (error, retest 1-2 months)
FeLV negative may result from non-exposure, early infection, a transient infection that has been eliminated, latent infection (ELISA, VI, IFA neg.), focal infection, discordance, or be a false negative.

General comments:
No cures for cats with FIV (FeLV or FIP).
Management options -

- Expose affected cat to as few infectious organisms as possible. It may need to be isolated, kept in a small stable group, or given a night curfew.
- It should be fed separately, and on a high quality diet.
- Exposure to parasites should be prevented. This is particularly so for fleas because they are believed to transmit *Mycoplasma haemofelis* (previously called *Haemobartonella felis).*
- Since stress will accentuate immune dysfunction, exposure to stressful situations should be minimised.
- Care with vaccination - only give if really needed, and then use killed vaccines.

- Regular health checks

Symptomatic treatment -
- Treat secondary infections early + aggressively
- Choose therapeutics with care
- Antivirals?
- Immune modulation
- Supplements?

Interferon (IFN):
- Low dose → ↑ immune responses
- High dose → Anti-viral + ↓ immune responses

hrIFNα2b - Intron A, Roferon-A
- FeLV: 70% improve clinical signs + live longer
- Wide dose range, given PO
- If SQ - fever, nausea, pain, ↓ appetite, and antibodies in ~3-7 weeks

Feline IFNω - Virbagen
- FeLV 1 M IU/kg SQ q24h, 5x

48 cats, death occurred in half as many treated cats as compared to controls; over 2 months
- IV, IM, SQ, PO?
- Side effects - 'flu'-like, GI upset, transient fever, ↓ platelets, ↓ wbc, ↓PCV

Antivirals:
Azidodideoxythymidine (AZT [Retrovir, Burroughs Wellcome] *5-10 mg/kg, PO, SC, or IV q12h).* Treatment has been associated with improvement of both clinical signs and immune status. Best responses often gained when combined with IFN. However, it is expensive (~£30 per month), and may cause severe side effects, particularly anaemia. Often best given in 3 week cycles, and stop treatment if PCV < 20%.

Treatment options for Sampson:
Exclusion diet
Fenbendazole (50 mg/kg PO q24h for 3 days)
Metronidazole (*Giardia* - 25 mg/kg q12-24h 5 days)(*IBD* 10 mg/kg q24h)
Prednisolone (1-2 mg/kg q24-48h)
Doxycycline (5 mg/kg q24h 3 weeks)
IFN, EFA, etc.

Lymphocytic lymphosarcoma of the SI was treated by increasing the prednisolone dose (2mg/kg PO q24) and adding in chlorambucil (0.5mg/kg PO twice weekly). The diarrhea resolved, Sampson regained some weight and is still well 2 years later.

Drug	Route	Cost/month	Monitoring
AZT	PO, SQ, IV q12h	~£30	√
hrIFNα	PO, SQ q24h	~£8	
FrIFNω	PO, SQ, IV q24	~£8-150	
G-CSF	SQ q12-24h <3wk	~£250	√
Human Ig	IV over 6-12h	~£90	√
EPO	SQ q24h	~£100	√

Table 1. Treatment Considerations for Cats with FeLV, FIV and FIP

THERAPY	USES AND COMMENTS
Bone marrow transplantation	Effective treatment for some primary immunodeficiencies. Expensive, not readily available.
Fresh whole blood transfusion *(contains leukocytes, immunoglobulins and compliment)*	Used to treat neutropenia, neutrophil dysfunction or overwhelming infections. Effect is transient. Risk of anaphylactic reaction with repeated transfusions.
Plasma transfusions	Effect is transient. Risk of anaphylactic reaction with repeated transfusions.
Human immunoglobulin (dogs) (0.5-1.5 g/kg, IV over 6-12h)	Effect is transient. Risk of anaphylactic reaction.
Granulocyte colony-stimulating factor (G-CSF) (5-20 µg/kg, SC, q12-24h, for 1-2 weeks)	May be beneficial in dogs and cats. Expensive. Treatment for > 3 weeks results in induction of antibodies and resultant neutropenia.
Lithium carbonate (11mg/kg, PO, q12h - dogs) (Toxic in cats)	Induces neutrophilia via release of colony-stimulating factors. Risk of nephrotoxicosis.
Non-specific immune stimulators; - - Feline recombinant interferon omega (frIFNω) e.g. Virbagen Omega, Virbac *(Doses suggested range up to 1 M IU/kg SQ q24h, for 5 days, practical dose 5x10^4 IU PO or SQ q24h)*[a] - Human recombinant interferon alpha (hrIFNα) (1-30 IU, PO, q24h, treat continuously or alternate weeks)[b] - Bovine lactoferrin (40mg/kg, topically to oral cavity, q24h, as needed) - Food supplements, herbal & homeopathy.	- Particularly useful for cats with FIV or FeLV-induced immunosuppression, or where dry FIP is strongly suspected. Parentrally dosing will not induce antibody production. - As above, but given parentrally will cause toxicity and induce antibody production. - Useful in the treatment of FIV or FeLV associated gingivitis / stomatitis. - Most lack proof of efficacy or safety.
Erythropoietin (100 IU/kg, SC, q48h, until desired PCV is reached, ~2 weeks)	Useful where anaemia companies leukopenia. Prolonged use may induce antibodies and result in severe anaemia.
Antiviral agent; Azidothymidine (AZT) (15mg/kg, PO or SC, q12h)[c]	May be useful in the management of FIV or FeLV-induced immunosuppression. Monitor for anaemia and other signs of toxicity.

IV, give intravenously. SC, give subcutaneously. PO, give per os. PCV, packed cell volume.
[a] Minimum purchase 25 M IU (~ £110). [b] Obtained as 3M IU (Intron A from Schering-Plough or Roferon A from Roche ~ £25) - dilute in one litre of saline, aliquot into 1ml volumes, freeze for up to a year. Easiest way is to freeze 1ml aliquots in 1.5ml plastic vials called Ependorphs (sold as microtubes code 6600-1019 from Whatman's Lab Sales Ltd, Unit 20-21, Transpennine Trading Estate, Rochdale, OL11 2PX, tel. 01622 676670, fax. 01622 677011; ~£20 for 1000). Defrost as required, dilute to required concentration*, keep refrigerated for up to 2 weeks. *If using 30 IU q24 hours dilute 1ml of the 3000 IU/ml in 9ml saline and use 0.1ml (30 IU) PO q24h. [c] For PO administration use customised gelatin capsules, for SC dilute lyophilate in 5ml of saline.

February 2004

Feline Hematology Dry Laboratory

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The objectives of this dry laboratory are:

1. To review the unique features and peculiarities of feline hematology.
2. To review and practice the examination and interpretation of feline blood smears.
3. To use clinicopathologic data to interpret and diagnose disorders in specific clinical case examples in the cat.

The laboratory will consist of:

1. A brief overview of feline hematology and principles and techniques of blood smear examination (lecture style).

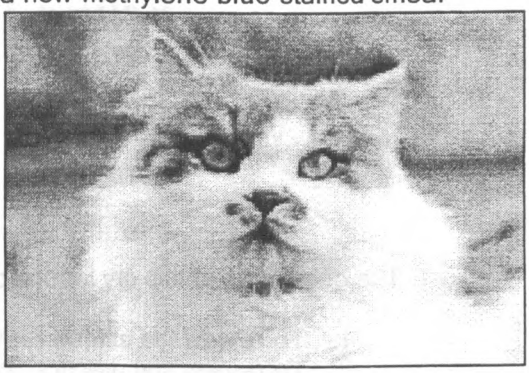
2. Four blood smears from different cases (Nico, Kyla, Mickey and Padiwak) are provided, along with pertinent clinical and clinicopathologic data. Data for these cats is provided in this handout, with instructions for each case.
   We have also established a course webpage which contains links to visual images from all these cases, including representative images of pertinent hematologic findings, and radiographic, cytologic and histopathologic results.
   We have provided microscopes equipped with oil immersion lenses and accessory equipment (oil immersion, kimwipes, lens cleaner).
   Please wipe the oil of the lenses thoroughly when you have finished.

   A wrap-up session will be held with each of these cases.

3. Five additional blood smears are provided to illustrate classic hematologic changes in certain diseases. A wrap-up session will not be held for these slides.
   These cases are:
   a. "Psycho": Heinz body hemolytic anemia and an inflammatory leukogram
   b. "Riley": Chronic lymphocytic leukemia
   c. "Anastasia": Poikilocytosis secondary to liver disease
   d. "Orange": An inflammatory leukogram in a cat with pancreatitis and steatites
   e. "Taco": Eosinophilia and basophilia in a cat with feline asthma

4. We have established a course webpage with the following:
   a. Images of the above 4 cases
   b. Images of selected demonstration slides
   c. Links to the Cornell University clinical pathology modules, including the hematology and red cell morphology atlases
   d. Differential cell counter.

Case 1 "Nico" Provided is a Wright's stained smear (Nico) and a new-methylene blue-stained smear (Nico NMB)



Nico, a domestic longhair neutered male cat of unknown age, presented to the SPCA with injured right and left hind limbs, presumably from a gunshot. On physical examination, he had a swollen, cold distal right hind limb with multiple crusted abrasions and a weak femoral pulse. He had pale mucous membranes with a normal capillary refill time, a heart rate of 126 b/min, respiratory rate of 36 breaths/minute and a temperature of 103.2F. On radiographs, he had comminuted fractures in all proximal metatarsals. Blood was collected for a hemogram and FeLV titer, prior to amputation of his right hind leg.

For this case, please perform a blood smear examination and fill in the missing values. Then integrate the provided laboratory data with the clinical signs.

========== HEMATOLOGY==========

HCT % (25-45) **15!**	HB g/dL (8.4-15.0) **4.8!**	RBC mill/µL (5.5-10.3) **2.7!**	MCV fL (41-51) **55!**	MCH pg (13-18) 18
MCHC g/dL (32-36) 33	RDW % (14.8-20.0) **21.4!**	RETIC % (0-1) **1.1!**	ABS RETIC thou/µL (< 60.0) 29.7	NUCL RBC /100 WBC (0) _____
aWBC thou/µL (6.2-14.4) **16.7!**	SEG N thou/µL (2.3-11.0) _____	BAND N thou/µL (0-0.1) _____	LYMPH thou/µL (1.2-6.9) _____	MONO thou/µL (0-1.1) _____
EOS thou/µL (0.1-2.3) _____	BASO thou/µL (0-0.2) _____	PLAT SMEAR _____	TP-REF g/dL (5.9-7.5) **8.4!**	

RBC MORPHOLOGY: _____

RBC PARASITES: _____

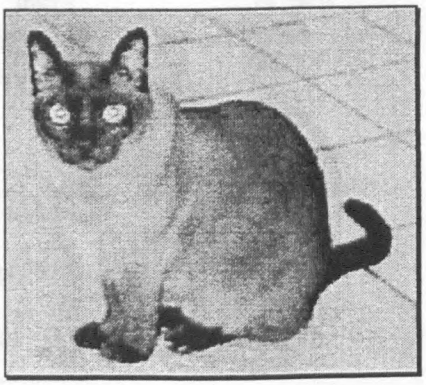
WBC MORPHOLOGY: _____

PLASMA APPEARANCE: Normal

Please also refer to the webpage to view pertinent images from Nico's hemogram

Case 2 "Kyla"

Provided is a Wright's stained smear of peripheral blood (Kyla)



Kyla is a 9-year-old female spayed Tonkinese. She is the only indoor cat in a three-cat, two-dog household. Kyla presented to the referring veterinarian with a 3 to 4 week history of coughing and gagging twice daily. The owner had used a spray polish excessively in the house, just prior to the onset of Kyla's clinical signs. None of the other animals appeared sick. On physical examination, harsh lung sounds were auscultated. The referring veterinarian placed Kyla on Tribrissen, however there was no improvement after one week and she became progressively lethargic and had lost weight. At this stage, Kyla had pale mucus membranes, with persistent harsh lung sounds. Kyla was referred to Cornell University for further evaluation.

On examination, Kyla was in good condition, but was fairly depressed, 3-5% dehydrated with pale pink mucous membranes. She had a heart rate of 240 beats/minute with a capillary refill time of <2 seconds. She had shallow breathing with a respiration rate of 42 breaths/minute; harsh lungs sounds were auscultated in all lung quadrants. A cough was not elicited on palpation of the trachea. No other abnormalities were noted on physical examination. Kyla was admitted into the hospital and blood was withdrawn for a hemogram, FeLV titer and biochemical profile. Urine was collected by cystocentesis for urinalysis.

For this case, please perform a blood smear examination and fill in the missing values. Please also view the website for color pictures of pertinent hematologic, radiographic and cytologic results.
Then integrate the provided laboratory data with the clinical signs.

==========HEMATOLOGY==========

HCT	HB	RBC	MCV	MCH
%	g/dL	mill/µL	fL	pg
(25-45)	(8.4-15.0)	(5.5-10.3)	(41-51)	(13-18)
22!	**7.1!**	**3.2!**	**68!**	**22!**

MCHC	RDW	RETIC	ABS RETIC	NUCL RBC /100 WBC
g/dL	%	%	thou/µL	
(32-36)	(14.8-20.0)	(0-1)	(< 60.0)	(0)
33	**23.9!**	0.2	6.4	_____

aWBC	SEG N	BAND N	LYMPH	MONO
thou/µL	thou/µL	thou/µL	thou/µL	thou/µL
(6.1-21.0)	(2.6-13.6)	(0)	(1.3-9.1)	(0-0.7)
87.4!	_____	_____	_____	_____

EOS	BASO	OTHER WBC	PLAT SMEAR	TP-REF
thou/µL	thou/µL	thou/µL		g/dL
(0.2-4.3)	(0-0.2)	(0)		(5.9-7.5)
_____	_____	_____	_____	**8.0!**

RBC MORPHOLOGY: _____

RBC PARASITES: _____

WBC MORPHOLOGY: _____

PLASMA APPEARANCE: Normal

Please also refer to the webpage to view pertinent images from Kyla's hemogram

==========URINALYSIS==========

COLOR	TURBIDITY	SP GRAV	pH-STIX	PROT-STIX
Yellow (Md)	Slt Cldy	1.022	6.5	Trace
GLUC-STIX	**KET-STIX**	**BILI-STIX**	**BLOOD-STIX**	**PROT-SSA**
Negative	Negative	Negative	Small	Trace
WBC/HPF	**RBC/HPF**	**BACTERIA**	**EPITH CELLS**	**SPERM**
5-20	5-20	None seen	Few	None seen
FAT DROP	**DEBRIS**			
Few	None seen			

CASTS/LPF: None seen
CRYSTALS: None seen

==========CHEMISTRY==========

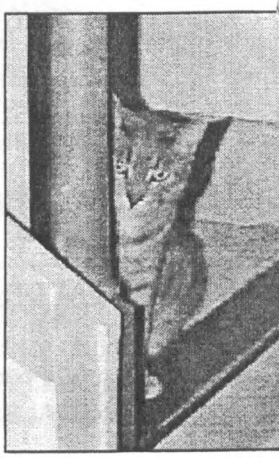
SODIUM	POTASSIUM	CHLORIDE	BICARB	ANION GAP
mEq/L	mEq/L	mEq/L	mEq/L	mEq/L
(146-160)	(3.9-5.5)	(118-128)	(15-30)	(7-19)
154	4.2	118	16	**24!**
NA:K	**UREA N**	**CREATININ**	**CALCIUM**	**PHOSPHATE**
	mg/dL	mg/dL	mg/dL	mg/dL
	(19-32)	(0.8-1.9)	(8.9-11.6)	(3.5-8.8)
37	23	1.9	11.3	5.0
TOT PROT	**ALBUMIN**	**GLOBULIN**	**A/G**	**GLUCOSE**
g/dL	g/dL	g/dL		mg/dL
(5.8-8.0)	(2.5-3.7)	(3.3-4.3)	(0.5-1.6)	(63-144)
7.9	3.5	**4.4!**	0.80	**149!**
ALT	**AST**	**ALK PHOS**	**GGT**	**TOT BILI**
U/L	U/L	U/L	U/L	mg/dL
(28-91)	(9-46)	(10-77)	(0-4)	(0-0.2)
26!	38	16	0	0.1
CK				
U/L				
(95-1294)				
156				

Imaging - please refer to the webpage to view these images
Thoracic radiographs showed marked narrowing of the intrathoracic and mainstem bronchi. Abdominal radiographs revealed mild hepatomegaly with equivocal enlargement of the right liver or a right cranial quadrant abdominal mass.

Cytology - The results can be viewed on the website.
A bone marrow aspirate was performed.

Endocrinology/Serology
A thyroid hormone (T4) value was measured. Her results were 1.51 µg/dl (reference interval, 1.5-4.0 µg/dl). Blood was also submitted for an FeLV titer.

Case 3 "Mickey" Provided is a Wright's stained smear of peripheral blood (Mickey).



Mickey is a 14 year old neutered male domestic shorthair cat. He presented to the Cornell University Hospital for Animals with a 1-2 day history of vomiting and partial anorexia. A splenectomy for a presumptive mast cell tumor had been performed by the referring veterinarian (histopathologic evaluation was not performed).
On physical examination, Mickey was alert and active. He was quite fractious, so a complete physical examination could not be performed. Mickey was admitted and blood was collected for hemogram and chemistry profile (heparin). Urine was collected for urinalysis by cystocentesis.

For this case, perform a blood smear examination and fill in the missing values. Please also view the website for color pictures of pertinent hematologic, cytologic and histopathologic results. Then integrate the provided laboratory data with the clinical signs.

==========HEMATOLOGY==========

aHCT % (32-52) **18!**	aHB g/dL (10.1-16.4) **5.2!**	aRBC mill/µL (6.9-10.9) **3.4!**	aMCV fL (40-52) **53!**	aMCH pg (13-16) 15
aMCHC g/dL (29-34) 29	aRDW % (13.6-20.3) 18.0	aRETIC % (0.1-0.6) **3.1!**	RETIC-abs thou/uL (8.6-55.8) **105.4!**	NUCL RBC /100 WBC (0) _____
aWBC thou/µL (5.3-16.6) **40.2!**	SEG N thou/µL (2.3-11.0) _____	BAND N thou/µL (0-0.1) _____	LYMPH thou/µL (1.2-6.9) _____	MONO thou/µL (0-1.1) _____
EOS thou/µL (0.1-2.3) _____	BASO thou/µL (0-0.2) _____	OTHER WBC thou/µL (0) _____	PLAT SMEAR _____	TP-REF g/dL (5.9-7.5) **10.8!**

RBC MORPHOLOGY: _____

RBC PARASITES: _____

WBC MORPHOLOGY: _____

PLASMA APPEARANCE: Normal

Please also refer to the webpage to view pertinent images from Mickey's hemogram

==========CHEMISTRY==========

SODIUM	POTASSIUM	CHLORIDE	BICARB	ANION GAP
mEq/L	mEq/L	mEq/L	mEq/L	mEq/L
(146-156)	(3.8-5.6)	(112-123)	(12-21)	(17-29)
151	4.0	117	17	19

NA:K	UREA	CREAT-rb	CALCIUM	PHOSPHATE
	mg/dL	mg/dL	mg/dL	mg/dL
	(17-35)	(0.7-2.1)	(8.2-11.5)	(3.0-6.6)
38	**85!**	**3.0!**	10.6	5.9

MAGNES-rb	TOT PROT	ALB-blk	GLOBULIN	A/G
mEq/L	g/dL	g/dL	g/dL	
(1.6-2.1)	(6.7-8.5)	(2.9-4.3)	(3.1-5.1)	(0.6-1.3)
1.8	**10.1!**	3.2	**6.9!**	**0.46!**

GLUCOSE	ALT/P5P	AST/P5P	ALK PHOS	GGT
mg/dL	U/L	U/L	U/L	U/L
(63-140)	(29-186)	(13-46)	(15-96)	(0-3)
160	37	13	51	<3

TOT BILI	DIR BILI	IND BILI	AMYLASE	CHOLESTER
mg/dL	mg/dL	mg/dL	U/L	mg/dL
(0-0.2)	(0-0.1)	(0-0.2)	(489-2100)	(73-265)
0.3!	0.0	**0.3!**	**2435!**	122

CK	IRON	TIBC	% SAT
U/L	µg/dL	µg/dL	%
(71-502)	(57-156)	(208-378)	(20-61)
55!	71	**431!**	**16!**

----------SPECIAL BLOOD CHEMISTRY----------

LIPEMIA	HEMOLYSIS	ICTERUS
79	11	0

==========URINALYSIS==========

VOLUME	COLOR	TURBIDITY	SP GRAV	cpH
3.0 mL	Yellow (Lt)	Slt Cldy	1.012	6

cProtein	cGlucose	cKetone	cBilirubin	cHemoprot
mg/dL	mg/dL	mg/dL	mg/dL	
30	Negative	Negative	Negative	Negative

PROT-SSA	WBC/HPF	RBC/HPF	BACTERIA	EPITH CELLS
1+	<5	<5	Mod*	None seen

SPERM	FAT DROP	DEBRIS
None seen	Very few	None seen

* Cocci

CASTS/LPF: None seen
CRYSTALS: None seen

Imaging
Abdominal ultrasonography confirmed a moderate mesenteric lymphadenopathy (jejunal, gastric and iliac nodes). A 4 cm section of jejunum appeared irregular in architecture, however there was no obvious increase in mucosal thickness.

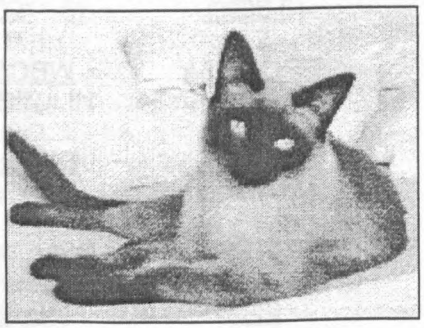
Cytology and histopathology - please refer to the website for pertinent pictures.
Unfortunately Mickey bit a student whilst hospitalized. Since his rabies vaccination status was not current, he was quarantined for 10 days. After this time, an exploratory laparotomy was performed. His liver was diffusely speckled with numerous white spots and he had generalized mesenteric lymphadenopathy. The intestines and other organs were grossly normal. Biopsies were taken from his liver, pancreas, stomach, duodenum, jejunum, ileum and duodenal lymph node. Imprints of the pancreatic and liver biopsies were made and submitted for cytologic examination. The harvested tissues were then sent for histopathologic evaluation. Mickey was then transferred to Oncology for further treatment.

Case 4 "Padiwak"

Provided is a Wright's stained smear of peripheral blood (Padiwak).

History and physical examination findings

Padiwak, a 10 year old spayed female Siamese cat, presented with a 5-6 day history of lethargy, inappetence progressing to anorexia, and acting sore allover. Prior to this illness, Padi had been a happy and healthy animal. Padiwak was an indoor cat, and had received FVRCP (feline viral rhinotracheitis, calicivirus and panleukopenia) and rabies vaccines 3 months ago. At that time she weighed 11 lbs. Two months earlier, the owners had bought a new kitten from a pet store - another purebred Siamese. The kitten remains apparently healthy at this time.



On physical examination, Padiwak is found to be extremely depressed, febrile (T=105.4 F), and mildly dehydrated. The sclera have a slight yellow tint. Body weight now is 9.5 lbs., and the hair coat is rough. The abdomen appears slightly distended, and you suspect that a significant amount of abdominal fluid is present. By palpation, a mid-abdominal mass of about 3 cm is detected. Blood was collected for a hemogram, coagulation panel (citrate) and chemistry profile (heparin). Urine was collected by cystocentesis for urinalysis.

For this case, perform a blood smear examination and fill in the missing values. Please also view the website for color pictures of pertinent hematologic, electrophoretic and cytologic results. Then integrate the provided laboratory data with the clinical signs.

==========HEMATOLOGY==========

aHCT % (32-52) **30!**	aHB g/dL (10.1-16.4) 10.1	aRBC mill/µL (6.9-10.9) 7.2	aMCV fL (40-52) 42	aMCH pg (13-16) 14
aMCHC g/dL (29-34) 34	aRDW % (13.6-20.3) **20.8!**	NUCL RBC /100 WBC (0) _____	aWBC thou/µL (5.3-16.6) **13.4!**	SEG N thou/µL (2.3-11.0) _____
BAND N thou/µL (0-0.1) _____	LYMPH thou/µL (1.2-6.9) _____	MONO thou/µL (0-1.1) _____	EOS thou/µL (0.1-2.3) _____	BASO thou/µL (0-0.2) _____
OTHER WBC thou/µL (0) _____	PLAT SMEAR _____	TP-REF g/dL (5.9-7.5) **9.4!**		

RBC MORPHOLOGY: _____

RBC PARASITES: _____

WBC MORPHOLOGY: _____

PLASMA APPEARANCE: Icterus - slight

Please refer to the webpage to view pertinent images from Padiwak's hemogram

==========URINALYSIS==========

VOLUME	COLOR	TURBIDITY	SP GRAV	cpH
3.0 mL	Yellow (Md)	Slt Cldy	1.017	7
cProtein mg/dL	cGlucose mg/dL	cKetone mg/dL	cBilirubin mg/dL	cHemoprot
500	50	Negative	Positive	4+
PROT-SSA	WBC/HPF	RBC/HPF	BACTERIA	EPITH CELLS
3+	<5	20-100	None seen	Few
SPERM	FAT DROP	DEBRIS	BILI-ICTO	
None seen	None seen	None seen	Positive	

CASTS/LPF: None seen
CRYSTALS: View representative image

========== COAGULATION PANEL ==========

PT	aPTT	TCT	FIBGEN	ATIII
sec	sec	sec	mg/dL	%
(14-20)	(14-18)	(5-8)	(75-175)	(100)
28!	**24!**	**12!**	**417!**	70

D-DIMER
ng/mL
(<250)
500-1000!

==========CHEMISTRY==========

SODIUM	POTASSIUM	CHLORIDE	BICARB	ANION GAP
mEq/L	mEq/L	mEq/L	mEq/L	mEq/L
(146-156)	(3.8-5.6)	(112-123)	(12-21)	(17-29)
152	3.1	120	19	**16!**
NA:K	UREA	CREAT-rb	CALCIUM	PHOSPHATE
	mg/dL	mg/dL	mg/dL	mg/dL
	(17-35)	(0.7-2.1)	(8.2-11.5)	(3.0-6.6)
49	**12!**	**0.5!**	11.2	4.2
MAGNES-rb	TOT PROT	ALB-blk	GLOBULIN	A/G
mEq/L	g/dL	g/dL	g/dL	
(1.6-2.1)	(6.7-8.5)	(2.9-4.3)	(3.1-5.1)	(0.6-1.3)
1.7	**9.0!**	**2.6!**	**6.4!**	**0.41!**
GLUCOSE	ALT/P5P	AST/P5P	ALK PHOS	GGT
mg/dL	U/L	U/L	U/L	U/L
(63-140)	(29-186)	(13-46)	(15-96)	(0-3)
162!	184	**189!**	**99!**	<3
TOT BILI	DIR BILI	IND BILI	AMYLASE	CHOLESTER
mg/dL	mg/dL	mg/dL	U/L	mg/dL
(0-0.2)	(0-0.1)	(0-0.2)	(489-2100)	(73-265)
2.6!	**1.8!**	**0.8!**	**4483!**	177
CK	IRON	TIBC	% SAT	
U/L	µg/dL	µg/dL	%	
(71-502)	(57-156)	(208-378)	(20-61)	
150	**310!**	310	**100!**	

----------SPECIAL BLOOD CHEMISTRY----------

LIPEMIA	HEMOLYSIS	ICTERUS
22	0	3

Imaging
Abdominal ultrasonography confirmed moderate ascites and a 5 cm mesenteric mass, which was likely a lymph node.

Cytology and histopathology - please refer to the website for pertinent pictures.
Abdominocentesis was performed and the peritoneal fluid was submitted for cytologic analysis. Aspirates of the mesenteric mass and liver were obtained under ultrasonographic guidance.

Further procedures
The serum and peritoneal fluid were submitted for total protein electrophoresis. Blood was collected for FeLV, FIV and FIPV titers.

Additional blood smears for reference only

"Psycho" This slide demonstrates a Heinz body hemolytic anemia

Psycho is an intact adult male domestic shorthair cat, who presented as an emergency with regurgitation of several months duration. On physical examination, he was severely depressed, dehydrated, weak and thin. He was regurgitating and had a purulent nasal discharge. Diagnostic evaluation revealed a megaosephagus from a perstistent right aortic arch. Unfortunately, he died after placement of a gastroscopy tube. A necropsy revealed necrotizing esophagitis and hepatic lipidosis, but no aspiration pneumonia.

Psycho also has an inflammatory leukogram, which can be attributed to the esophagitis and potential rhinitis. A cause for the oxidant damage (e.g. Tylenol toxicity) was not identified. In contrast to Nico, Psycho has large Heinz bodies attached to his erythrocytes, which are readily visible. Some of these are free in the background. They contribute to the HB concentration, thus causing an artefactually high MCH and MCHC. Their large size is diagnostic for a Heinz body hemolytic anemia, which is usually regenerative. In this case, the regenerative response may be suppressed from inflammatory disease.

==========HEMATOLOGY==========

aHCT	aHB	aRBC	aMCV	aMCH
%	g/dL	mill/µL	fL	pg
(32-52)	(10.1-16.4)	(6.9-10.9)	(40-52)	(13-16)
14!	**5.4!**	**3.2!**	44	17
aMCHC	aRDW	RETIC	RETIC-abs	aWBC
g/dL	%	%	thou/uL	thou/µL
(29-34)	(13.6-20.3)	(0.1-0.6)	(8.6-55.8)	(5.3-16.6)
39	**21.5!**	**1.4!**	44.8	**54.4!**
SEG N	BAND N	LYMPH	MONO	EOS
thou/µL	thou/µL	thou/µL	thou/µL	thou/µL
(2.3-11.0)	(0-0.1)	(1.2-6.9)	(0-1.1)	(0.1-2.3)
48.4!	**2.7!**	1.6	1.1	**0.0!**
BASO	PLAT SMEAR	TP-REF		
thou/µL		g/dL		
(0-0.2)		(5.9-7.5)		
0.5!	Adeq.	6.4		

RBC MORPHOLOGY:	**Polychromasia - mild, Macrocytes - few, Ghost cells, Heinz bodies - many**
RBC PARASITES:	None seen
WBC MORPHOLOGY:	**Toxic changes in neutrophils - moderate**
PLASMA APPEARANCE:	Icterus - slight

"Riley" Chronic lymphocytic leukemia (CLL) and intestinal lymphoma
Images of Riley's hematologic, cytologic and histopathologic results can be viewed on the website.

Riley is a 7-year-old neutered male domestic shorthair cat. He presented to CUHA with a 1 year history of diarrhea. In the prior 4 days, he became anorexic and vomited. A marked lymphocytosis (53.5 thou/µl) was documented 4 months previously and he had tested negative for FeLV, FIV and toxoplasmosis. Riley was thin and cachectic. A diffusely thickened small intestine and enlarged mesenteric lymph nodes were palpated.
Riley has a lymphocytosis of small mature lymphocytes, compatible with CLL. This is in contrast to Kyla, in which blasts dominated. CLL is diagnosed by a persistent lymphocytosis, with no identifiable underlying cause. Histopathologic evaluation of pinch biopsies of his duodenal mucosa (obtained by gastroduodenoscopy) indicated a low-grade intermediate B-cell lymphoma. A bone marrow aspirate revealed a granulocytic hyperplasia, however a leukemic infiltrate was not identified. This is not surprising in CLL, because the leukemia typically arises in the spleen. There is the remote possibility that Riley has a lymphoma cell leukemia secondary to his intestinal lymphoma, but this would be extremely rare in the cat.

==========HEMATOLOGY==========

aHCT	aHB	aRBC	aMCV	aMCH
%	g/dL	mill/µL	fL	pg
(32-52)	(10.1-16.4)	(6.9-10.9)	(40-52)	(13-16)
32	10.4	**6.8!**	47	15
aMCHC	aRDW	aWBC	SEG N	BAND N
g/dL	%	thou/µL	thou/µL	thou/µL
(29-34)	(13.6-20.3)	(5.3-16.6)	(2.3-11.0)	(0-0.1)
33	15.1	**176.1!**	**12.7!**	0.0
LYMPH	MONO	EOS	BASO	PLAT SMEAR
thou/µL	thou/µL	thou/µL	thou/µL	
(1.2-6.9)	(0-1.1)	(0.1-2.3)	(0-0.2)	
158.5!	**1.8!**	**3.5!**	0.0	Adeq.
aPLAT	aMPV	TP-REF		
thou/uL	fL	g/dL		
(201-523)	(10.8-19.8)	(5.9-7.5)		
227	17.1	**8.8!**		

RBC MORPHOLOGY: No significant abnormalities
RBC PARASITES: None seen
WBC MORPHOLOGY: The lymphoid cells are mostly small mature lymphocytes, with a few intermediate cells. They have indented to deeply cleaved nuclei.
PLASMA APPEARANCE: Normal

"Anastasia" This slide demonstrates poikilocytosis due to hepatic lipidosis

Anastasia is a 5 year old neutered female domestic shorthair cat, who presented with a one month history of anorexia and intermittent vomiting. Diagnostic evaluation revealed a diffusely enlarged hypoechoic liver, which was confirmed as hepatic lipidosis on aspiration.

Anastasia has numerous poikilocytes. This is a general term indicating variation in erythrocyte shape. We use this term when there are so many shape changes that we cannot categorize them all individually or doing so does not provide additional information. This degree of poikilocytosis is a marker of underlying hepatic disease, particularly (but not always) lipidosis. Other poikilocytes which may dominate in liver disease are echino-elliptocytes (oak or holly-leafed shaped cells), keratocytes, schistocytes and acanthocytes. Note these red cell changes can be seen in other conditions, including neoplasia (secondary to chemotherapeutic agents) and renal disease.

==========HEMATOLOGY==========

aHCT	aHB	aRBC	aMCV	aMCH
%	g/dL	mill/µL	fL	pg
(32-52)	(10.1-16.4)	(6.9-10.9)	(40-52)	(13-16)
34	10.9	7.1	48	15
aMCHC	**aRDW**	**aWBC**	**SEG N**	**BAND N**
g/dL	%	thou/µL	thou/µL	thou/µL
(29-34)	(13.6-20.3)	(5.3-16.6)	(2.3-11.0)	(0-0.1)
32	16.2	10.0	8.6	0.0
LYMPH	**MONO**	**EOS**	**BASO**	**PLAT SMEAR**
thou/µL	thou/µL	thou/µL	thou/µL	
(1.2-6.9)	(0-1.1)	(0.1-2.3)	(0-0.2)	
1.2	0.2	**0.0!**	0.0	Adeq.
aPLAT	**aMPV**	**TP-REF**		
thou/µL	fL	g/dL		
(201-523)	(10.8-19.8)	(5.9-7.5)		
322	13.9	**8.1!**		

RBC MORPHOLOGY: **Poikilocytes - many (includes echino-elliptocytes, schistocytes and acanthocytes), Polychromasia - mild, Howell-jolly bodies - few**

RBC PARASITES: None seen

WBC MORPHOLOGY: No significant abnormalities

PLASMA APPEARANCE: **Icterus - moderate**

"Orange" This slide demonstrates an inflammatory leukogram

Orange is a 5 year old neutered male domestic shorthair cat, who presented with a 2 day history of inappetance, vomiting and malaise. On physical examination, he was depressed, febrile and icteric. Diagnostic evaluation revealed an abdominal effusion which was compatible with an exudate. He had a mid-abdominal hypoechoic mass, which was identified during exploratory laparotomy as a cecal lymph node abscess (confirmed by cytology). Unfortunately, Orange did poorly and a necropsy revealed a traumatic-induced pancreatitis, diffuse necrotizing steatitis and multifocal hepatitis. The icterus was attributed to the hepatitis, pancreatitis and sepsis.

Orange has an inflammatory leukogram, characterized by a neutrophilia and left shift with moderate toxic change. The anemia was acutely developing and attributed to blood losses from surgery, hemolysis from inflammatory disease, and cytokine-suppression from inflammatory disease (lack of regeneration could also be due to the acuteness of the anemia). The thrombocytopenia could be related to DIC. Cats with inflammatory leukograms can have a metarubricytosis (nucleated RBCs).

==========HEMATOLOGY==========

aHCT	aHB	aRBC	aMCV	aMCH
%	g/dL	mill/µL	fL	pg
(32-52)	(10.1-16.4)	(6.9-10.9)	(40-52)	(13-16)
15!	**5.2!**	**3.2!**	48	16
aMCHC	aRDW	NUCL RBC /100 WBC	RETIC	RETIC-abs
g/dL	%		%	thou/uL
(29-34)	(13.6-20.3)	(0)	(0.1-0.6)	(8.6-55.8)
34	16.3	**1.0!**	0.1	3.2
aWBC	SEG N	BAND N	LYMPH	MONO
thou/µL	thou/µL	thou/µL	thou/µL	thou/µL
(5.3-16.6)	(2.3-11.0)	(0-0.1)	(1.2-6.9)	(0-1.1)
51.7!	**39.3!**	**6.7!**	3.1	**2.6!**
EOS	BASO	PLAT SMEAR	aPLAT	TP-REF
thou/µL	thou/µL		thou/µL	g/dL
(0.1-2.3)	(0-0.2)		(201-523)	(5.9-7.5)
0.0!	0.0	Low	**82!**	5.9

RBC MORPHOLOGY:	No significant abnormalities
RBC PARASITES:	None seen
WBC MORPHOLOGY:	**Toxic changes in neutrophils - moderate**
PLASMA APPEARANCE:	**Icterus - marked**

"Taco" This slide demonstrates eosinophils and basophils

Taco is a 12 year old neutered female domestic shorthair cat. She presented as an emergency with a distended abdomen and dyspnea. A cardiac murmur was detected when she was a kitten. Diagnostic evaluation revealed hypertrophic cardiomyopathy with pleural and peritoneal effusion. Both fluids were transudative, although the pleural fluid had a high proportion of eosinophils. She did not respond to supportive care and was euthanized. A necropsy revealed hypertrophic cardiomyopathy and lung changes compatible with feline asthma (which explains the eosinophilia and basophilia). A cause for the mildly regenerative anemia and severe thrombocytopenia was not apparent. The neutrophilia and monocytosis could be a chronic inflammatory or stress-related leukogram.

==========HEMATOLOGY==========

aHCT % (32-52) **24!**	aHB g/dL (10.1-16.4) **7.7!**	aRBC mill/µL (6.9-10.9) **5.3!**	aMCV fL (40-52) 46	aMCH pg (13-16) 15
aMCHC g/dL (29-34) 32	aRDW % (13.6-20.3) **20.4!**	RETIC % (0.1-0.6) **1.4!**	RETIC-abs thou/uL (8.6-55.8) **74.2!**	aWBC thou/µL (5.3-16.6) **25.9!**
SEG N thou/µL (2.3-11.0) **13.0!**	BAND N thou/µL (0-0.1) 0.0	LYMPH thou/µL (1.2-6.9) 1.6	MONO thou/µL (0-1.1) **1.8!**	EOS thou/µL (0.1-2.3) **8.6!**
BASO thou/µL (0-0.2) **1.0!**	PLAT SMEAR Low	aPLAT thou/µL (201-523) **19!**	TP-REF g/dL (5.9-7.5) 7.5	

RBC MORPHOLOGY:	**Polychromasia - mild, Howell-jolly bodies - few**
RBC PARASITES:	None seen
WBC MORPHOLOGY:	No significant abnormalities
PLASMA APPEARANCE:	Normal

Electronic Resources for Practicing Veterinarians: Update, June 2004

Susanne K. Whitaker, M.L.S., A.H.I.P.
Veterinary Reference Librarian
Flower-Sprecher Veterinary Library
Cornell University
Sunday, August 1, 2004

Technology and the World Wide Web are making an increasing amount of information available electronically. This can be a significant advantage to practicing veterinarians in private practice who know "how" and "where" to get it. Nevertheless, there are still obstacles to e-journal access and arrangements can be confusing. In addition, while there is a lot of free material available, it may be necessary to pay for access to e-journal subscriptions or by the individual article such as pay-per-view. Finally, as with any electronic resource, it is important to "know your source" since there is no peer review on the Internet.

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The attached pages list some important resources (both free and moderate cost) that may be useful in finding and accessing helpful animal-health related information electronically.

I. Electronic Access to Veterinary Journals for Practicing Veterinarians
II. Books and Conference Proceedings for Practicing Veterinarians
III. Other Selected Electronic Resources for Practicing Veterinarians

If questions or comments, feel free to contact me at anytime at skw2@cornell.edu, by phone (607-253-3499), or fax (607-253-3080).

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
A	B	C	D	E
I. BOOKS				
INTERNET ONLINE				
BSE Inquiry:The Report (1998)	U.K. Department for Environment, Food and Rusal Affairs / Animal Health & Welfare	Online	http://www.bseinquiry.gov.uk/report/index.htm http://www.defra.gov.uk/animalh/bse/index.html	Free to all
Compendium on Veterinary Products (CVP)		Online	American Animal Hospital Assoc. MarketLink http://www.aahamarketlink.com/ American Veterinary Medical Association http://www.avma.org Veterinary Information Network (VIN) http://www.vin.com/	Requires membership
Dental Encyclopedia. / Dr. Bellows		Online	VIN http://www.vin.com/	Requires membership
The 5-Minute Veterinary Consult: Canine and Feline. 3rd ed. / Smith & Tilley.	Lippincott Williams & Wilkins	Online	VetMedCenter.com http://www.vetmedcenter.com	Requires membership
Foreign Animal Diseases "The Gray Book". (1998)	United States Animal Health Association	Online	http://www.vet.uga.edu/vpp/gray_book/index.htm	Free to all; print vol. may be purchased
Merck Veterinary Manual	Merck & Company	Online	http://www.merckvetmanual.com/mvm/index.jsp	Free; print & CD-ROM may be purchased

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Various titles including: National Need and Priorities for Veterinarians in Biomedical Research (2003) The Use of Drugs in Food Animals: Benefits and Risks (1999) Guide for the Care and Use of Laboratory Animals (1996) Science, Medicine, and Animals (1991) Cattle Inspection (1990) Diagnosis and Control of Johne's Disease (2003) Laboratory Animal Management: Dogs (1994) Infectious Diseases of Mice and Rats (1991) and more.....	National Academies Press	Online	http://www.nap.edu/catalog/	Free to all; print vols. may be purchased
Nutrient Requirements of Cats, Rev. ed, (1986) (New edition: Nutrient Requirements of Dogs and Cats. (2003))	National Research Council/ National Academies Press	Online	http://www.nap.edu/books/0309036828/html/index.html	Free; print may be purchased
Nutrient Requirements of Dogs, Rev. ed. (1985) (New edition: Nutrient Requirements of Dogs and Cats (2003).	National Research Council / National Academies Press	Online	http://www.nap.edu/books/0309034965/html/	Free; print may be purchased
Nutrient Requirements of Horses, 5th Rev. ed. (1989)	National Research Council / National Academies Press	Online	http://www.nap.edu/books/0309039894/html/	Free; print may be purchased
Small Animal Clinical Nutrition. 4th ed / Hand	Mark Morris Foundation	Online	VetMedCenter.com http://www.vetmedcenter.com	Requires membership

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
The State of Animals I: 2001 / Salem & Rowan (2001)	Humane Society Press	Online	http://www.hsus.org/ace/13167	Free; also available in print
The State of Animals II: 2003 / Salem & Rowan. (2003)	Humane Society Press	Online	http://www.hsus.org/ace/2009	Free; also available in print
Various E-books and chapters: Avian, Bovine, Companion Animals, Equine, Exotic and Zoo species, Porcine and Small Ruminants/Camelids written by international experts	International Veterinary Information Service (IVIS) (Ithaca, NY)	Online	International Veterinary Information Service (IVIS) http://www.ivis.org	Free with registration
Various articles by authors including: [Behavior] / Schwartz. [Cattle] / Maas. [Housetraining] / Smith.	iknowledgenow.com / Douglas Novick DVM	Online	iknowledgenow.com http://www.iknowledgenow.com/	Requires registration and fees
Various book chapters from Teton New Media publications:(coming soon) Echocardiography for the Small Animal Practitioner. Ophthalmology for the Small Animal Practitioners. Quick Look Series....	iknowledgenow.com / Douglas Novick DVM	Online	iknowledgenow.com http://www.iknowledgenow.com/	Requires registration and fees
Veterinary Drug Handbook. 4th ed. / Plumb		Online	Veterinary Information Network http://www.vin.com/	VIN Online version requires membership
CD-ROM				
Dorland's Electronic Medical Speller.	Saunders / Elsevier	CD-ROM	http://www.elsevier.com	Purchase; also in print
Dorland's Pocket Medical Dictionary	Saunders / Elsevier	CD-ROM	http://www.elsevier.com	

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
English & Spanish Medical Words & Phrases. 3rd ed.	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	
Stedman's Medical Dictionary. 27th ed.	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	Purchase
Stedman's Plus Version 2004 Medical/Pharmaceutical Spellchecker (Windows/Mac)	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	Purchase; also online deliverable
Ageing of Horses. / Knottenbelt.		CD-ROM	http://www.blackwellpublishing.com	
The Art of Equine Auscultation.	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Birds of Prey / Harcourt-Brown (2000)	Zoological Education Network	CD-ROM	http://www.zen-inc.com/catalog.cfm http://www.exoticdvm.com/default.asp	
Bovine Clinical Diagnosis and Therapy. / Scott R. Haskell et al.	College of Vet. Med. Univ. of Minnesota	CD-ROM		
Common Small Animal Diagnoses. / Davies	Elsevier	CD-ROM	Elsevier http://www.elsevier.com/	Purchase
Control of the Bovine Estrous Cycle	Society for Theriogenology	CD-ROM		
Direct Smear Atlas. / Marter, Siders, Allen	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	
Diseases of Poultry. Ed. / Saif etal.	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com	
Diseases of Swine. Ed. / Straw etal.	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com	
Equine Upper Airway Examination	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

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Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Exotic Companion Animal Surgeries. / Lightfoot & Bartlett. (1999)	Zoological Education Network	CD-ROM	http://www.zen-inc.com/catalog.cfm http://www.exoticdvm.com/default.asp	
Exotic Medicine Library: Avian Medicine Avian Viruses Exotic Companion Medicine Handbook	Wingers Publishing (Fla.)	CD-ROM		
The 5-Minute Veterinary Consult: Canine and Feline for PDA. 3rd ed. / Smith & Tilley.	Lippincott Williams & Wilkins	CD-ROM	Publisher http://www.lww.com	Purchase; also in print
The 5-Minute Veterinary Consult: Equine. / Brown & Bertone.	Lippincott Williams & Wilkins	CD-ROM	Publisher http://www.lww.com	Purchase; also in print
Formulary for Laboratory Animals. / Hawk.	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com	
The Glass Horse [Equine anatomy interactive] (2001)	Univ. of Georgia. College of Vet. Med.	CD-ROM	http://www.3Dglasshorse.com	
Guide to Plant Poisonings of Animals in North America / Knight & Walter.	Teton New Media	CD-ROM	http://www.veterinarywire.com	Purchase; also in print
Handbook of Small Animal Toxicology & Poisonings. / Gfeller & Messonnier.	Mosby	CD-ROM	http://www.elsevier.com	Purchase; also in print
Handbook of Veterinary Drugs PDA. / Woods, Dowling, Allen, etal.	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com/	Purchase; also in print
The Horse's Foot	LifeLearn	CD-ROM	http://www.lifelearn.com	
Infectious and Parasitic Diseases of Wild Animals. / Williams & Samuel.	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com	
Illustrated Dictionary of Fish and Shellfish. / Frimodt.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Illustrated Veterinary Encyclopedia for Horseman. (2000)	Equivision	CD-ROM	http://www.equivision.com	

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

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Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Individual Infertile Cow. / Noakes.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Interactive Learning in Dermatology / Lloyd & Halliwell.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Introduction to Veterinary Pathology. / Cheville	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com	
Lameness in Dairy Cattle / Murray & Woldehiwet	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Made Easy Series: ECG Pain Management Dermatology Thoracic Radiology Abdominal Radiology Neurology 2-Dimensional & M-Mode Echocardiography Equine Ophthalmology Broodmare Reproduction	Teton New Media	CD-ROM	Teton New Media VeterinaryWire http://www.veterinarywire.com	
MediClip Veter inary Anatomy.	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	Purchase
Merck Veterinary Manual. 8th ed. (2004) - Win/Mac	Merck & Company	CD-ROM	Elsevier http://www.elsevier.com/	
Normal Canine Retina / Bedford.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Otitis in Dogs and Cats / Griffin, etal.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Pain: How to Understand, Recognize, Treat, Stop. / Karol A> Mathews.	Jonkar Publishing	CD-ROM	http://www.jonkar.com/	
Poisonous Plants: A Veterinary Guide to Toxic Substances. / Fowler. (1998)	Univ. of California, Davis	CD-ROM		

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
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Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Prevention of Plant Poisonings in Livestock and Pets. / Meldrum & Kok (1999)	Virginia Polytechnica Institute and State Univ.	CD-ROM		
Recognition of Foreign Animal Diseases: A Refernce and Learning Tool: Classical Swine Fever (Hog Cholera) & African Swine Fever Exotic Newcastle Disease & Avian Influenza. Vesicular Diseases of Swine.	U.S. Dept of Agriculture. Animal and Plant Health Inspection Service (APHIS)	CD-ROM	http://www.capella.edu	
Saunders Handbook of Veterinary Drugs - CD-ROM, PDA / Papich.	W.B. Saunders / Elsevier	CD-ROM	Elsevier http://www.elsevier.com/	Downloadable PDA software
Small Animal Durg Handbook. / Morgan.	Saunders / Elsevier	CD-ROM PDA	Elsevier http://www.elsevier.com/	Downloadable PDA software
Small Animal Ultrasound. / Green.	Lippincott Williams & Wilkins	CD-ROM	Lippincott Williams & Wilkins http://www.lww.com	
Small Ruminant Clinical Diagnosis and Therapy. / Scoot R. Haskett, etal. (2001)	Univ. of Minnesota, Coll. Of Vet Med	CD-ROM		
The Urinary System / Brown.	Blackwell Publishing	CD-ROM	http://www.blackwellpublishing.com	
Veterinary Drug Handbook. 4th ed. / Plumb	Iowa State Press	CD-ROM	http://www.blackwellpublishing.com http://www.vetsoftware.com/products-other.htm	
Veterinary Emergency on CD-ROM	Legacy Interactive / Elsevier	CD-ROM	Elsevier http://www.elsevier.com/	
Veterinary Ophthalmology Essentials with CD-ROM / Grahn, Cullen & Peiffer. (2004)	Elsevier	CD-ROM	Elsevier http://www.elsevier.com/	Print volume plus cases and questions on CD-ROM
CLIENT HANDOUTS				

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Canine and Feline Behavior Problems. 3rd ed. / Schwartz.		CD-ROM	http://www.vetsoftware.com/products-clientinstruct.htm	Purchase
Canine and Feline Medical and Surgical Problems. 3rd ed. / Erlewein & Kuhns.		CD-ROM	http://www.vetsoftware.com/products-clientinstruct.htm	Purchase
Client Handouts: Equine	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Client Handouts: Behavior	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Client Handouts: Canine	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Client Handouts: Exotics & Pet Birds	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Client Handouts: Feline	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Client Handouts: Pharmacy	LifeLearn	CD-ROM	http://www.lifelearn.com	Purchase
Instructions for Equine Clients. 3rd ed. / Mansmann & Miller.		CD-ROM	http://www.vetsoftware.com/products-clientinstruct.htm	Purchase
Dr. Foil's Dermatology Client Handouts		Online	Veterinary Information Network (VIN) http://www.vin.com	Requires membership
PDA Versions for Handheld Computers				
Dorland's Pocket Medical Dictionary	Saunders / Elsevier	PDA	http://www.elsevier.com	Downloadable PDA software
English & Spanish Medical Words & Phrases. 3rde d. for PDA.	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Online deliverable version.
Stedman's Abbreviations, Acronyms & Symbols. 3rd ed. for PDA	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Online deliverable version.
Stedman's Concise Medical Dictionary for the Allied Health Professions. 4th ed. for PDA	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Online deliverable version.
Stedman's Medical Dictionary. 27th ed. for PDA	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Online deliverable version.
Common Small Animal Diagnoses: Algorithmic Approach. / Davies.	Elsevier	PDA	Elsevier http://www.elsevier.com/	Downloadable PDA software

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
ECG's for the Small Animal Practitioner: Palm OS eBook	Teton New Media	PDA	Teton New Media VeterinaryWire http://www.veterinarywire.com	Purcahse
The 5-Minute Veterinary Consult: Canine and Feline for PDA. 3rd ed. / Smith & Tilley.	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Purchase; also in print; Also Online deliverable version.
The 5-Minute Veterinary Consult: Equine for PDA / Brown & Bertone.	Lippincott Williams & Wilkins	PDA	Publisher http://www.lww.com	Purchase; also in print; Also Online deliverable version.
Foreign Animal Diseases "The Gray Book". (1998)	United States Animal Health Association	PDA	http://www.vet.uga.edu/vpp/gray_book/handheld/index.htm	Free to all; print vol. may be purchased
Pain Management for the Small Animal Practitioner: Palm OS e-Book	Teton New Media	PDA	Teton New Media VeterinaryWire http://www.veterinarywire.com	
Handbook of Veterinary Drugs PDA. / Woods, Dowling, Allen, etal.	Lippincott Williams & Wilkins	PDA	http://www.lww.com/	Purchase; also in print
Saunders Handbook of Veterinary Drugs - CD-ROM, PDA / Papich.	W.B. Saunders / Elsevier	PDA	Elsevier http://www.elsevier.com/	Downloadable PDA software
Small Animal Drug Handbook. / Morgan.	Saunders / Elsevier	PDA	Elsevier http://www.elsevier.com/	Downloadable PDA software
Veterinary Drug Handbook. 4th ed. / Plumb	Iowa State Press	PDA	http://www.blackwellpublishing.com http://www.vetsoftware.com/products-other.htm Online at VIN: http://www.vin.com	
II. CONFERENCE PROCEEDINGS				

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Various veterinary conference proceedings	Biblioteheque de Medecine Veterinariaire, Universite de Montreal (Quebec)	Online	http://www.medvet.umontreal.ca/biblio/gopher/bases/default.htm	Free to all
Agricultural Conferences, Meetings and Seminars (2004, 2005, 2006)	Various sources	Links	Agriculture Network Information Center (AgNIC) http://laurel.nal.usda.gov:8080/agnic/mtg/2004l.html	Free to all
Various proceedings including: AAEP Proceedings 2003 Genes, Dogs and Cancer Conf. (2001-2003) Geneva Congress on Equine Med. & Surg. (2003) Havermeyer Found. Workshops in Equine Vet. Med. (1999-2003) World Equine Veterinary Congress (1997-2003) Am. Coll. of Veterinary Pathologists (2004) Am. Coll. Of Veterinary Radiology (1999-2003) World Equine Vet. Assoc, (1997, 1999, 2001, 2003) Internat. Symp. On Equine Reprod. (var. 1974-2002) World Small Animal Vet. Assoc. (2001-2002) and more.....	Various sources	Online	International Veterinary Information Service (IVIS) http://www.ivis.org	Free; requires registration

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

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Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
Various proceedings On-Line, including: Am. Assoc. of Feline Pract. (1999-2000) Pfizer: Managing Pain...2003 Symposium Tufts Breeding & Genetics Conf. (2003) Am. College of Vet. Scientists (2002-2003) Western Veterinary Conf. (2003) ACVIM (1998, 2002-2003) Waltham Feline Medicine (2003) and more.....	Various sources	Online	Veterinary Information Network (VIN) http://www.vin.com	Requires membership
AAEP Proceedings 2003	Am. Assoc. of Equine Practitioners	Online	International Veterinary Information Service (IVIS) http://www.ivis.org	Free with registration
AAHA Scientific Proceedings	Am. Animal Hospital Assoc.	Online	AAHA http://www.aahanet.org	Members only
ACVIM Proceedings	Am. College of Veterinary Internal Medicine	Online	ACVIM http://www.acvim.org Veterinary Information Network http://www.vin.com/	Member attendees only
American College of Veterinary Radiology (1999-2003)		Online	International Veterinary Information Service (IVIS) http://www.ivis.org	Free; requires registration
American College of Veternary Surgeons (2001-2003)		Online	iknowledgenow.com http://www.iknowledgenow.com/	
AASV Proceedings	Am. Assoc. of Swine Veterinarians	CD-ROM	Am. Assoc. of Swine Veterinarians http://www.aasp.org	Purchase
Bayer Zoonosis Symposium 2003 Proceedings Online	North American Vet. Conf.	Online	Veterinary Information Network (VIN) http://www.vin.com	Requires membership

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

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Cornell University Veterinary Library

Electronic Books and Conference Proceedings for Practicing Veterinarians

TITLE / NAME	Publisher / Producer	Full-Text Online	Source / Vendor	Access Method
United States Animal Health Association 2002 Proceedings	U.S. Animal Health Assoc.	Online	http://www.usaha.org/contents.html	Free to all
Tufts Animal Expo Conference Proceedings		Online	iknowledgenow.com http://www.iknowledgenow.com/	

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Appendix:

II. Electronic Books and Conference Proceedings for Practicing Veterinarians

A. Title / Name

B. Publisher / Producer

C. Full-Text Online
Internet - Online
CD-ROM
PDA - Handheld Computer, Personal Digital Assistant

E. Source/Vendor for Electronic Full-Text

1. Vendor or aggregator
International Veterinary Information Service (IVIS)
http://www.ivis.org/

Veterinary Information Network (VIN)
http://www.vin.org/

iknowledgenow
http://www.iknowledgenow.com/

2. Associations or organizations
American Animal Hospital Association
American College of Veterinary Internal Medicine

3. Publishers
National Academies Press
http://www.nap.edu/catalog/

G. Access Method for Electronic Full-Text

1. Free access to all on the Web

2. Free online access with registration
International Veterinary Information Service (IVIS)
http://www.ivis.org/

3. Free online access with professional association/organization membership (Often by UserID and password)

Direct from publisher/source

Through an authorized vendor

4. Purchase of CD-ROM or PDA version
LifeLearn
http://www.lifelearn.com/

Lippincott Williams & Wilkins
http://www.lww.com/

Elsevier
http://www.elsevier.com/

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
A	B	C	D	E	F	G
I. Veterinary Journals Indexed in Index Medicus (2003)						
Acta Veterinaria Hungarica	Akademiai Kaido (Budapest)					
Acta Veterinaria Scandinavica	Vet. Assoc. of the Nordic Countries					
Acta Veterinarian Scandinavia. Supplementum	Vet. Assoc. of the Nordic Countries					
Advances in Veterinary Medicine	Academic Press (Elsevier)					
Alternatives to Laboratory Animals: ATLA	FRAME (U.K.)				http://www.frame.org.uk/atlafn/atlaintro.htm	
American Journal of Veterinary Research	Am. Vet. Med. Assoc.		Online	2000-	AVMA http://www.avma.org	Membership/subscription UserID and password
Anatomia, Histologia, Embryologia. Journal of Veterinary Medcine C. (Journal of the World Assoc. of Veterinary Anatomists)	Blackwell		Online	2000-	Ingenta Online Journals	Requires subscription
Animal Cognition	Springer					
Animal Genetics	Blackwell		Online	1997-	Blackwell Synergy 1998- Ingenta 1997-	Requires subscription
Animal Health Research Reviews (Conf. Of Research Workers in Animal Diseases)	CABI Publishing					
Animal Reproduction Science	Elsevier		Online	1995-	ScienceDirect	Requires subscription

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Archiv fur Tiernahrung						
Australian Veterinary Journal	Australian Vet. Assoc.		Online	1996-	http://www.ava.com.au	Members only--current issues Free to all back issue (1996-2003)
Avian Diseases	Am. Assoc. of Avian Pathologists		Online	2002-	BioOne	Requires subscription
Avian Pathology: Journal of the W.V.P.A.	Taylor & Francis		Online	1999-	Taylor & Francis http://www.tandf.co.uk/journals/online/0307-9457.asp MetaPress 1999- http://www.metapress.com Ingenta 2003-	Requires subscription
Berliner und Munchener Tierarztliche Wochenschrift	Schluetersche Verlagsgesellschaft http://www.schluetersche.de					
British Poultry Science	Taylor & Francis		Online	1998-	Ingenta Select	Requires subscription
Canadian Journal of Veterinary Research / Revue Canadienne de Recherche Veterinaire.	Canadian Vet. Med. Assoc.	X			Canad. Vet. Med. Assoc. http://www.cvma-acmv.org/ http://www.canadianveterinarians.net/vetjournals/cjvr/index.html	
Canadian Veterinary Journal / Le Revue Veterinaire Canadienne.	Canadian Vet. Med. Assoc.	X			Canad. Vet. Med. Assoc. http://www.cvma-acmv.org/ http://www.canadianveterinarians.net/vetjournals/cvj/index.html	
Clinical Techniques in Small Animal Practice	W.B. Saunders/Elsevier		Online	2003-	ScienceDirect	Requires subscription

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Comparative Immunology, Microbiololgy and Infectious Diseases	Pergamon (Elsevier)		Online	1995-	Elsevier ScienceDirect	Requires subscription
Comparative Medicine	Am. Assoc. for Laboratory Animal Science	X			http://www.aalas.org/education/publications/about_CM.htm	Requires subscription
Contemporary Topics in Laboratory Animal Science	Am. Assoc. for Laboratory Animal Science	X			http://www.aalas.org/education/publications/ctonline.htm	Requires subscription
Domestic Animal Endocrinology	Elsevier		Online	1995-	ScienceDirect	Requires subscription
DTW. Deutsche Tierarztliche Wochenschrift	Shaper					
Equine Veterinary Journal	Equine Veteirnary Journal LTD				http://www.evj.co.uk/pages/journals.html	Free online index
Equine Veterinary Journal. Supplement	Equine Veteirnary Journal LTD				http://www.evj.co.uk/pages/journals.html	
Experimental Animals	Japanese Assoc. for Laboratory Animal Science					
Fish & Shellfish Immunology	Elsevier		Online	1993-	ScienceDirect	Requires subscription
ILAR Journal	Nat. Res. Council. Institute for Laboratory Animal Research		Online	1989-	http://dels.nas.edu/ilar/jour_online.asp?id=jour_online	Free to all
Japanese Journal of Veterinary Research	Graduate School of Vet. Med., Hokkaido Univ. (Sapporo, Japan)					

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

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Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Journal of Animal Physiology and Animal Nutrition	Blackwell		Online	1999-	Blackwell Synergy 1999- Ingenta 2000-	Requires subscription
Journal of Animal Science	Am. Soc. of Animal Science		Online	1990-	HighWire ProQuest 1997-2002	Requires subscription
Journal of Applied Animal Welfare Science: JAAWS	Lawrence Erlbaum Associates		Online	2000-	Lawrence Erlbaum Associates http://www.leaonline.com/	Requires subscription
Journal of Comparative Pathology	Elsevier		Online	1999-	ScienceDirect	Requires subscription
Journal of Dairy Research	Cambridge Univ. Press		Online	1997-	Cambridge Journals Online	Requires subscription
Journal of Dairy Science	Am. Dairy Science Assoc.		Online	1995-	HighWire	Membership or subscription
Journal of Feline Medicine and Surgery	W.B. Saunders/Elsevier		Online	1999-	ScienceDirect	Requires subscription
Journal of Small Animal Practice	Brit. Small Animal Vet. Assoc.		Online	2002-	Ingenta	Requires subscription
Journal of the American Animal Hospital Association	Am. Animal Hospital Assoc.		Online	1998-	HighWire	Membership or subscription
Journal of the American Veterinary Medical Association	Am. Vet. Med. Assoc.		Online	2000-	AVMA http://www.avma.org	Membership or subscription User ID and Password
Journal of the South African Veterinary Association	South African Vet. Assoc.					
Journal of Veterinary Diagnostic Investigation	Am. Assoc. of Vet. Laboratory Diagnosticians					

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Journal of Veterinary Internal Medicine	Am. College of Vet. Internal Medicine / Lipincott Williams & Wilkins	X			http://www.acvim.org/wwwfp/jvim/jvim.htm	
Journal of Veterinary Medical Education	Assoc. of Am. Vet. Med. Colleges	X			http://www.utpjournals.com/JVME/JVME.html	
Journal of Veterinary Medical Science	Japanese Society of Veterinary Science		Online	1997-	http://www.soc.nii.ac.jp/jsvs/JVMS/jvms.html	Free to all
Journal of Veterinary Medicine. A, Physiology, Pathology, Clinical Medicine	Blackwell		Online	1999-	Blackwell Synergy 1999- Ingenta 2000-	Requires subscription
Journal of Veterinary Medicine. B, Infectious Diseases and Veterinary Public Health	Blackwell		Online	1999-	Blackwell Synergy 1999- Ingenta 2000-	Requires subscription
Journal of Veterinary Pharmacology and Therapeutics	Blackwell		Online	1997-	Blackwell-Synergy Ingenta	Requires subscription
Journal of Veterinary Science (Suwon-si, Korea)	Korean Society of Veterinary Science					
Journal of Wildlife Diseases	Wildlife Disease Assoc.					
Journal of Zoo and Wildlife Medicine	Am. Assoc. of Zoo Veterinarians		Online	2000-	BioOne	Requires subscription
Lab Animal Laboratory Animals	Royal Society of Medicine Press (U.K.)		Online	2001-	Ingenta Royal Society of Med. Press http://www.rsmpress.co.uk/la.htm	Requires subscription
Medical and Veterinary Entomology	Blackwell		Online	1998-	Ingenta	Requires subscription
Onderstepoort Journal of Veterinary Research	ARC-Onderstepoort Veterinary Institute		Online	2003-	http://www.journals.co.za/ej/ejour_opvet.html	Requires subscription

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Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Polish Journal of Veterinary Sciences						
Poultry Science	Poultry Science Assoc.		Online	1997-	Poultry Science Association http://www.poultryscience.org	Membership or subscription
Preventive Veterinary Medicine	Elsevier		Online	1995-	ScienceDirect	Requires subscription
Reproduction in Domestic Animals=Zuchthygiene	Blackwell		Online	1999-	Blackwell Synergy	Requires subscription
Research in Veterinary Science	Elsevier		Online	1998-	ScienceDirect	Requires subscription
Revue Scientifique et Technique / Scientific and Technical Review	World Organization for Animal Health- Office International des Epizooties (OIE)	X		1990-	http://www.oie.int/eng/publicat/en_revue.htm	
Schweizer Archiv for Tierheilkunde						
Theriogenology	Elsevier		Online	1995-	ScienceDirect	Requires subscription
Tijdschrift voor Diergeneeskunde						
Tropical Animal Health and Production	Kluwer		Online	1998-	Kluwer Journals Online	Requires subscription
Veterinary and Human Toxicology	Comparative Toxicology Laboratories, Kansas State Univ.					
Veterinary Clinical Pathology	Am. Soc. For Veterinary Clinical Pathology	X	Online	2000-	http://www.vetclinpathjournal.org 2000- Abstracts 1990-1999	Free to all
Veterinary Clinics of North America: Equine Practice	W.B. Saunders/Elsevier		Online	2002-	http://www.theclinics.com	Free with print for limited time as of Mar. 2004

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Veterinary Clinics of North America: Exotic Animal Practice	W.B. Saunders/Elsevier		Online	2002-	http://www.theclinics.com	Free with print for limited time as of Mar. 2004
Veterinary Clinics of North America: Food Animal Practice	W.B. Saunders/Elsevier		Online	2002-	http://www.theclinics.com	Free with print for limited time as of Mar. 2004
Veterinary Clinics of North America: Small Animal Practice	W.B. Saunders/Elsevier		Online	2002-	http://www.theclinics.com	Free with print for limited time as of Mar. 2004
Veterinary Dermatology	Blackwell		Online	1995-	Blackwell Synergy 1998- Ingenta 1995-	Requires subscription
Veterinary Immunology and Immunopathology	Elsevier		Online	1995-	ScienceDirect	Requires subscription
Veterinary Journal (Formerly: British Veterinary Journal)	Bailliere Tindall (Elsevier)		Online	1999-	ScienceDirect	Requires subscription
Veterinary Microbiology	Elsevier		Online	1995-	ScienceDirect	Requires subscription
Veterinary Parasitology	Elsevier		Online	1995-	ScienceDirect	Requires subscription
Veterinary Pathology	Am. College of Veterinary Pathologists		Online	1997-	HighWire	Requires subscription
Veterinary Quarterly	Euroscience (The Netherlands)		Online	2004-	http://www.euroscience.nl/index.html	Requires password
Veterinary Radiology & Ultrasound	Blackwell		Online		Ingenta 1960-date contents at http://www.acvr.ucdavis.edu/journal/journal.html	Membership or subscription
Veterinary Record	Brit. Vet. Assoc.				http://www.vetrecord.co.uk/vrcurrent.htm	

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Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Veterinary Research	EDP Sciences (Paris)		Online	2000-	EDP Sciences	Requires subscription
Veterinary Research Communications	Kluwer		Online	1997-	Kluwer Journals Online	Requires subscription
Veterinary Surgery	Blackwell		Online		Ingenta	Membership or subscription
Veterinary Therapeutics: Research in Applied Veterinary Medicine	Veterinary Learning Systems	X			http://www.vetlearn.com/vetther.html	Index available online Sample issues
II. Selected Veterinary Journals NOT Indexed In Index Medicus						
American Farriers Journal	Lesser Publications		Online		http://www.lesspub.com/cgi-bin/site.pl?afj/onlyOnline	Free to all
Animal Biotechnology	Dekker		Online		http://www.dekker.com/index.jsp http://www.dekker.com/servlet/product/productid/ABIO	Pay per view
Animal Science Journal=Nihon Chikusan Gakkai	Blackwell		Online	2002-	Blackwell Synergy	Requires subscription
Animal Sheltering	Humane Society of the United States		Online	1997-	Humane Soc. Of the U.S. http://www.animalsheltering.org	Free to all
Annual Review of Fish Diseases			Online	1995	ScienceDirect	
AWI Quarterly [Animal Welfare Institute]			Online		http://www.awionline.org/pubs/quarterly.html	Free to all
Aquatic Mammals	European Assoc. for Aquatic Mammals					

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Australian Veterinary Practitioner	Aust. Small Animal Vet. Assoc.	X			http://www.ava.com.au/content/asava/avp.htm	Membership or subscription
AVI: Assoc. for Veterinary Informatics Newsletter (Formerly: American Veterinary Computing Society)	Assoc. for Vet Informatics		Online	1992-	http://www.avinformatics.org/	Free to all
Bovine Practitioner	Amer. Assoc. of Bovine Practitioners					
Clinical Techniques in Equine Medicine	W.B. Saunders (Elsevier)					
Compendium on Continuing Education for the Practicing Veterinarian	Veterinary Learning Systems	X			http://www.vetlearn.com/pvlong.html	Contents index online
Dansk Veterinaer Tidsskrift						
Diseases of Aquatic Organisms	Inter-Research (Germany)		Online	2000-	http://www.int-res.com/journals/dao/	Requires subscription
DVM: The Newsmagazine of Veterinary Medicine	ADVANSTAR Veterinary Healthcare Communications				http://www.dvmnewsmagazine.com	
Equine and Comparative Exercise Physiology	CABI Publishing					
Equine Disease Quarterly	Dept. of Vet. Science, Univ. of Kentucky				http://www.uky.edu/Agriculture/VetScience/Q_articles.html	Free online index
Equine Veterinary Education	Equine Veterinary Journal LTD				http://www.evj.co.uk/pages/journals.html	Free online index
Equus	Primedia				http://equisearch.com	
Ethology	Blackwell		Online	1999-	Blackwell Synergy 1999- Ingenta 2000-	Requires subscription
Exotic DVM Veterinary Magazine	Zoological Education Network (Fla.)				http://www.exoticdvm.com/AboutUs.asp#	

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
FAO/OIE World Animal Health	World Organization for Animal Health- Office International des Epizooties (OIE)		Online	2001-	http://www.oie.int/eng/info/en_sam.htm	Free to all
FDA Veterinarian	U.S. Food & Drug Admin.		Online		http://www.fda.gov/cvm/index/fdavet/1999/1999toc.html	Free to all
Fish Pathology	Japanese Society of Fish Pathology					
Goat Veterinary Society Journal	Goat Veterinary Society (U.K.) VetLink					
Hoofcare and Lameness	Hoofcare & Lameness: The Journal of Equine Foot Science					
In Practice	Brit. Vet. Assoc.				http://vetrecord.co.uk/ip	
Indian Veterinary Journal						
International Zoo Yearbook						
Irish Veterinary Journal	Veterinary Ireland					
Journal. American Holistic Veterinary Medical Association	Am. Holistic Vet. Med. Assoc.		Online	1998-	ProQuest - Ethnic NewsWatch Complete http://www.enw.proquest.com	Membership???
Journal of Animal Breeding and Genetics	Blackwell		Online	2000-	Ingenta	Requires subscription
Journal of Aquatic Animal Health	American Fisheries Service		Online	1998-	American Fisheries Service http://afs.allenpress.com/afsonline	Free????
Journal of Applied Research in Veterinary Medicine	Veterinary Solutions				http://www.jrnlappliedresearch.com/Veterinary/	Requires subscription

Note: This information is subject to change at any time due to the evolving nature of electronic resources.

Prepared by Susanne Whitaker, Reference Librarian
Cornell University Veterinary Library

Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Journal of Avian Medicine and Surgery	Assoc. of Avian Veterinarians http://www.aav.org/publications.html		Online	2000-	BioOne	Requires subscription
Journal of Equine Veterinary Science	Elsevier		Online	2003-	ScienceDirect	Requires subscription
Journal of Fish Biology Journal of Fish Diseases	Blackwell		Online	1999-	Blackwell Synergy	Requires subscription
Journal of Herpetological Medicine and Surgery	Assoc. of Reptilian and Amphibian Veterinarians http://www.arav.org					
Journal of Swine Health and Production	Am. Assoc. of Swine Veterinarians		Online		http://www.aasp.org	Included with membership
Journal of Veterinary Cardiology (European Soc. Of Veterinary Cardiology)	FCM Graphic					
Journal of Veterinary Dentistry	Am. Vet. Dental Soc.				http://www.jvdonline.org	Free to all
Journal of Veterinary Emergency and Critical Care	Blackwell		Online	2002-	http://www.blackwellpublishing.com/	Reqyires registration
Journal of Veterinary Medical Science	Japanese Society of Veterinary Science				http://www.soc.nii.ac.jp/jsus/	Free to all
Marine Mammal Science	Society for Marine Mammology					
Le Medecin Veterinaire du Quebec	Fac. Vet Med., Univ. de Montreal (Quebec, Ca.)					

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Prepared by Susanne Whitaker, Reference Librarian
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Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
New Zealand Veterinary Journal	New Zealand Vet. Assoc.		Online	v.1, 1952-	IngentaSelect	Membership or subscription
OIE Disease Information	World Organization for Animal Health- Office International des Epizooties (OIE)		Online	2002-	http://www.oie.int/eng/info/hebdo/a_info.htm	Free to all
OJVR: Online Journal of Veterinary Research			Online	1996-	http://www.uq.edu.au/~csvguerr/promo.htm http://www.cpb.uokhsc.edu/ojvr/	Subscription
Pakistan Veterinary Journal						
The Pig Journal: Journal of the Pig Veterinary Society (U.K.) (Formerly: Proceedings of the Pig Veterinary Society)	The Pig Veterinary Society (U.K.)		Online	1976-	http://www.pigjournal.co.uk/ http://www.pigjournal.co.uk/content/indexc.htm	Also, on CD-ROM
Praktische Tierarzt						
Primates	Springer Verlag		Online	2003-	http://www.springerlink.com/	
Revue de Medecine Veterinaire	Ecole Nationale Veterinaire de Toulouse (Fr.)					
Seminars in Avian and Exotic Pet Medicine	W.B. Saunders (Elsevier)					
Small Ruminant Research	Elsevier		Online	1995-	ScienceDirect	
State Veterinary Journal	Defra: Department for Environment, Food and Rural Affairs / Animal Health and Welfare (U.K.)		Online	2001-	http://www.defra.gov.uk/animalh/svj/fefault.htm	Free to all

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Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Tierarztliche Praxis	Schattauer	X			http://www.schattauer.com	
Trends Magazine [practice management]	Amer. Animal Hosp. Assoc.		Online		http://www.aahanet.org	Requires membership
UK Vet: Journal for the Veterinary Surgeon in General Practice	UK Vet Publications				http://www.ukvet.co.uk	
Vector Borne and Zoonotic Diseases	Mary Ann Liebert		Online	2001-	http://lysander.ingentaselect.com/vl=862832/cl=67/nw=1/rpsv/catchword/mal/15303667/contp1.htm	Requires subscription
Veterinary and Comparative Orthopaedics and Traumatology: VCOT	Schattauer	X			http://www.schattauer.com	
Veterinary Anaesthesia and Analgesia (Formerly: Journal of Veterinary Anaesthesia)	Blackwell		Online	2000-	Blackwell Synergy Ingenta	Requires subscription
Veterinary and Comparative Oncology	Blackwell		Online	2003-	Blackwell Synergy	Requires subscription
Veterinary Economics	ADVANSTAR Veterinary Healthcare Communications	X			http://www.vetmedpub.com/	
Veterinary Forum	Veterinary Learning Systems	X			http://www.vetlearn.com/vflong.html	
Veterinary Heritage: Bulletin of the American Veterinary History Society	Am. Vet. History Soc.					
Veterinary History: Journal of the Veterinary History Society (U.K.)	Vet. History Society (U.K.)					
Veterinary Medicine	ADVANSTAR Veterinary Healthcare Communications	X			http://www.vetmedpub.com/	Reprint collections available for purchase Individual reprints @$6.95

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Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Veterinary Neurology and Neurosurgery			Online	1999-2004	http://www.neurovet.org/TableofContents.htm	Free to all
Veterinary News	New York State Veterinary Medical Society					
Veterinary Ophthalmology	Blackwell		Online	1998-	Blackwell Synergy 1998- Ingenta 1999-	Requires subscription
Veterinary Technician	Veterinary Learning Systems	X			http://www.vetlearn.com/techlong.html	Index available online
Vet-Online: The International Journal of Veterinary Medicine			Online	????	http://www.priory.com/vet.htm	???
Vlaams Diergeneeskunde						
Waltham Focus: A Worldwide Journal for the Companion Animal Veterinarian	Waltham					
Wildlife Rehabilitation Today	Coconut Creek Publishing (Fla.)				http://www.wildliferehabtoday.com	
Zoo Biology	Wiley Interscience		Online	1997-	Wiley Interscience http://www3.interscience.wiley.com	Requires subscription
III. Selected Non-Veterinary Journals						
American Journal of Primatology	AR Liss/Wiley		Online	1997-	Wiley Interscience Journals http://	Requires subscription
Emerging Infectious Diseases	U.S. Centers for Disease Control and Prevention		Online	1995-	U.S. CDC http://www.cdc.gov/ncidod/EID/index.htm	Free to all

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Electronic Access to Veterinary Journals for Practicing Veterinarians

8/01/04

Veterinary Journal Titles	Publisher / Producer	TOC & Abstr.	Full-text	Years Online	Source / Vendor	Access Method
Journal of Experimental Medicine	Rockefeller Univ. Press	TOC 1965-1974	Online	1975-	HighWire	Requires subscription
Journal of Helminthology	CABI Publishing		Online	1999-	Ingenta	Requires subscription
Journal of Medical Primatology	Blackwell		Online	2000-	Ingenta	Requires subscription
Journal of Parasitology	Amer. Society of Parasitologists		Online	2000-	BioOne	Requires subscription
MMWR: Morbidity and Mortality Weekly Reports	U.S. Centers for Disease Control and Prevention		Online	1982-	U.S. CDC http://www.cdc.gov/mmwr/	Free to all
Parasitology	Cambridge University Press		Online	1997-	Cambridge Journals Online	Requires subscription
Pure-Bred Dogs: American Kennel Gazette	American Kennel Club					
Weekly Epidemiology Record (WER)	World Health Org.		Online	1926-	WHO http://www.who.int/wer/en/	Free to all

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Appendix:

I. **Electronic Access to Veterinary Journals for Practicing Veterinarians**

A. Journal Titles

Veterinary Journals Indexed In Index Medicus (2003)

Selected Veterinary Journals NOT Indexed in Index Medicus

Selected Non-Veterinary Journals

B. Publisher / Producer

C. Table of Contents and Abstracts

Most publishers' web sites display tables-of-contents and/or abstracts free of charge.

PubMed MEDLINE also includes abstracts for about 80% of the articles indexed.

"Quick Links to PubMed Abstracts of Recent Articles in Veterinary Journals
International Veterinary Information Service (IVIS)
Simply click on "All", "Small Animal", "Equine", Ruminants" and "Porcine"

"The VIN Journal Library"
Veterinary Information Network (VIN)
Includes tables-of-contents and abstracts from about 80 veterinary journals.

Current Veterinary Journals
Bibliotheque de Medecine Veterinaire, Universite de Montreal
http://www.medvet.umontreal.ca/biblio/vetjr.html
"Includes over 260 veterinary journals with tables of contents added daily upon reception of new issues in our veterinary library"

D. Full-Text Online

PDF format (Portable Document Format)
Requires a PDF reader on your computer.
Download Adobe Acrobat Reader free of charge
http://www.adobe.com/ Click "Get Reader"

HTML (HyperText Markup Language)

E. Beginning Year Online
The years offered by various vendors for the same title may vary.
Few publishers are retrospectively converting back volumes prior to about 1995 into electronic format at this point.

F. Source/Vendor for Electronic Full-Text

1. Vendor or aggregator

BioOne
http://www.bioone.org/

Ingenta
http://www.ingenta.com/
"The most comprehensive collection of academic and professional publications available for online, fax and Ariel delivery."

PubMed Central (PMC)
http://www.pubmedcentral.nih.gov/
"is the U.S. National Library of Medicine's digital archive of life sciences journal literature."

All titles listed at the PubMed Central site are "open access" titles that are free of charge to all.

HighWire: Library of the Sciences and Medicine (Stanford University)
http://highwire.stanford.edu
Some titles are completely free, others are free after 6 months, and some are full subscription price.

2. Associations or organizations

American Veterinary Medical Association
http://www.avma.org/

Canadian Veterinary Medical Association
http://www.cvma-acmv.org/

Poultry Science Association
http://www.poultryscience.org/

3. Publishers

Blackwell Synergy
http://www.blackwell-synergy.com/
"Online journals from Blackwell Publishing."

Kluwer Online
http://www.kluweronline.com/

Science Direct (Elsevier)
http://www.sciencedirect.com/
"World's best resource for research journals, abstract databases and reference works"

G. Access Method for Electronic Full-Text

1. Free access to all on the Web

PubMed Central
http://www.pubmedcentral.nih.gov

Non-profit organizations
HighWire
http://highwire.stanford.edu/

2. Free online access after 6-months online by registration

British Medical Journal
New England Journal of Medicine

3. Free access with professional association/organization membership

UserID and password (individuals)

IP (Internet Protocol) Address (computer network "address") (institutions)

Direct from publisher/source

Through an authorized online journal vendor or source (e.g., HighWire)

4. Subscription options

Electronic only
Electronic and Print
Print only

5. Pay-per-view or copies-paid-on-demand
From publisher or vendor

Enter credit card number to all access for a limited time

Veterinary Learning Systems / VetLearn
http://secure.vetlearn.com/pvsearch/pvsearch.cfm

TO ACCESS E-JOURNALS:

1. Free access
Simply connect to the web site of the publisher, vendor or source at any time.

2. Membership access
Obtain a UserID and password in advance from the association.

Connect to the association or vendor web site.
Enter a UserID and password

3. Aggregator or vendor access
a. Obtain a UserID and password, subscription number, and/or register in advance.

Connect to the aggregator or vendor website
Enter a UserID and password OR automatically connect by a computer IP address.

b. Choose pay-per-view
Select the article you want.
Enter credit card number.
View PDF version (requires Adobe Acrobat Reader - Download this program free from http://www.adobe.com/)

BioOne
BioOne does not currently offer a pay-per-view option to individuals. However, an arrangement has been made with Infotrieve, a document delivery supplier, to provide copies of articles from any of the BioOne online journals.
Contact Infotrieve for details and to place a request at
http://www.infotrieve.com/

Blackwell Publishing / Blackwell Synergy
Pay-per-view - All articles @ $19 to 30 each article

Elsevier. ScienceDirect
Pay-per-view - All articles @ $30 each article

Ingenta
Pay-per-view - Selected articles depending on the publisher @ $15-20 per article

Other Selected Electronic Resources for Practicing Veterinarians

8/01/2004

TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
A	B	C	D	E
BIBLIOGRAPHIC DATABASE MANAGERS				
EndNote (Windows & Mac)	Thomson ISI (Philadelphia, PA)		http://www.endnote.com/	Purchase; periodic updates
RefWorks	RefWorks (San Diego, CA)	Online	http://www.refworks.com/	Annual subscription @ $70
DATABASES--BIBLIOGRAPHIC				
PubMed MEDLINE (Index Medicus)	U.S. National Library of Medicine (Bethesda, MD)	Online	U.S. National Library of Medicine http://pubmed.gov	Free to all
Agricola (Bibliography of Agriculture)	U.S.National Agricultural Library (Beltsville, MD)	Online	U.S. National Agricultural Library http://www.nal.usda.gov/ag98/ag98.html	Free to all
CAB Abstracts (Includes Index Veterinarius & Veterinary Bulletin citations)	CAB Publishingl (U.K.)	Online	http://www.cabi-publishing.org/AboutAbstractDatabases.asp	$150/yr for veterinarians
Searchable Veterinary Literature Database: Companion 8.0	LifeLearn	CD-ROM	http://www.lifelearn.com/c2/2000b.html	Purchase @$99
Veterinary Journal Index: Your Practice Index to Veterinary Journals. (Formerly: The Veterinary Librarian)	Marty Page (Littleton, CO)	CD-ROM	http://vjindex.com/	Free sample online $195/ 1st year for 4-section package
TOXNET (Toxicology Information Online)	U.S. National Library of Medicine (Bethesda, MD)	Online	U.S. National Library of Medicine http://toxnet.nlm.nih.gov	Free to all
DATABASES--DIAGNOSTIC				
Consultant: A Diagnostic Support System for Veterinary Medicine	Dr. Maurice E. (Pete) White, Cornell University	Online	Cornell College of Vet. Med. http://www.vet.cornell.edu/consultant/consult.asp	Free to all

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Cornell University Veterinary Library

Other Selected Electronic Resources for Practicing Veterinarians

TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
DATABASES--OTHER				
Animal Health and Production Compendium	*CABI Publishing*	Online & CD-ROM	http://www.cabi.org/compendia/ahpc/	$100 for 1 personal Internet or CD-ROM
Food Animal Residue Avoidance Databank (FARAD)	U.S. Dept. of Agriculture	Online	http://www.farad.org/	Free to all Some sections require registration
Online Mendelian Inheritance in Animals (OMIA)./ F.W. Nicholas.	Faculty of Vet. Science, Univ. of Sydney (Aust.)	Online	http://www.angis.su.oz.au/Databases/BIRX/omia/	Free to all
WILDPro	Wildlife Information Network (U.K.)	Online & CD-ROM		Requires subscription
CONTINUING EDUCATION				
Various Autotutorials (Interactive, case-based learning modules) and Information Websites, Lecture Notes, and Manuals	Various	Online & Links	International Veterinary Information Service (IVIS) http://www.ivis.org	Free with registration
LifeLearn Interactive CD-ROM products	LifeLearn (Univ. of Guelph)	CD-ROM	http://www.lifelearn.com/	Purchase
Small Animal Continuing Education / ReferenCE series	LifeLearn (Univ. of Guelph)	CD-ROM	http://www.lifelearn.com/c2/2000a.html	Purchase

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Other Selected Electronic Resources for Practicing Veterinarians

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TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
Veterinary Staff Training (VST) series Numerous titles, including: Enhancing Your Telephone Skills Essentials of Client Services Perception of Value Pet Loss and Client Grief Nutrition Safety in the Veterinary Practice Vaccination	LifeLearn (Univ. of Guelph)	CD-ROM	http://www.lifelearn.com/c4/4000.html	Purchase
Veterinary Information Network (VIN)	Veterinary Information Network (VIN)	Online	http://www.vin.com/CE/	Membership + extra $ for CE courses
Veterinary Support Personnel Network (VSPN)	Veterinary Information Network (VIN)	Online	http://www.vspn.org/ce/	Registration + extra $ for CE courses
VetMedTeam: Your Online Education Resource		Online	http://www.vetmedteam.com/	Free membership + extra $ for CE courses
Veterinary Management Institute	AAHA / Purdue Univ.		http://www.aahanet.org/Educ/Educ_VMI.html	Fee-based program
Public CE Courses/ Previously held courses	Various	Online	Veterinary Information Network (VIN) http://www.vin.com	Free with registration
CURRENT AWARENESS SERVICES				
Focus On: Veterinary Science and Medicine	Thomson ISI (Philadelphia, PA)	Diskette	http://www.isinet.com/products/litres/focuson/focusonvet/	Purchase ; monthly updates on diskette
INNO-VET for the Practicing Veterinarian	INNO-VET / Dr. Ray Markus	Online	http://www.inno-vet.com/	Free to all
[Alerts directly from various publishers]	Various publishers		Sign up on publisher's web sites	Free with sign up
Veterinary Science Tomorrow		Online	http://www.vetcite.org/	Free to all
DISEASE SURVEILLANCE				

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TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
Animal and Plant Health Inspection Service	U.S. Dept of Agric.		http://www.aphis.usda.gov/	Free to all
Centers for Disease Control and Prevention	U.S. Dept. of Health and Human Services		http:/www.cdc.gov/	Free to all
World Health Organization	WHO		http://www.who.int/en/	Free to all
DOCUMENT DELIVERY SOURCES				
Document Delivery Suppliers	Jean Shipman, Virginia Commonwealth Univ.	Links to suppliers' web sites	http://www.library.vcu.edu/tml/docsupp/	List of numerous commercial document suppliers.
Loansome Doc Ordering System	U.S. National Library of Medicine & numerous affiliated medical libraries	Links to medical libraries	http://www.nlm.nih.gov/loansomedoc/loansome_home.html	Requires pre-registration; costs vary depending on supplier
Veterinary Medical Libraries	Ken Ladd (Saskatoon, SK)	Links to vet libraries	http://duke.usask.ca/~ladd/vet_libraries.html	List of U.S. and international veterinary libraries
Vet*Access*	Flower-Sprecher Veterinary Library/Cornell University (Ithaca, NY)	Online request form	http://www.vet.cornell.edu/library/vetaccess.html	Fee-based research and document delivery service.
DRUG & TOXICOLOGICAL SUBSTANCES SOURCES				
Compendium on Veterinary Products (CVP)		Online	American Animal Hospital Assoc. (MarketLink) http://www.aahamarketlink.com/ American Veterinary Medical Assoc. http://www.avma.org Veterinary Information Network (VIN) http://www.vin.com	Requires membership

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TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
Materials Safety Data Sheets (MSDS)		Online	American Animal Hospital Assoc. MarketLink http://www.aahamarketlink.com/ American Veterinary Medical Assoc. http://www.avma.org Veterinary Information Network (VIN) http://www.vin.com	Requires membership
Household Products Database (includes section on "Pet Products")	U.S. National Library of Medicine (Bethesda, MD)	Online	U.S. National Library of Medicine http://hpd.nlm.nih.gov	Free to all
IVIS Veterinary Drug Database	International Veterinary Information Service (IVIS) (Ithaca, NY)	Online	http://www.ivis.org/vetprod/drugs/toc.asp	Free; registration required
GUIDE SITES				
NetVet / Electronic Zoo	Ken Boschert, DVM (St. Louis)	Online	http://netvet.wustl.edu	Free to all
VetGate: The UK's Gateway to High Quality Internet Resources in Animal Health	University of Nottingham (U.K.)	Online	http://vetgate.ac.uk/	Free to all
ONLINE DISCUSSION GROUPS				
AVMA Network of Animal Health (NOAH (20 discussion groups)	Am. Vet Med. Assoc.(Schaumburg, IL)	Online	http://www.avma.org	NOAH membership
Veterinary Information Network (VIN)	Veterinary Information Network (Davis, CA)	Online	http://www.vin.com	Membership
VetMedCenter.com	VetMedCenter.com / Drs. Larry Tilley & Francis W.K. Smith Jr. (San Francisco, CA)	Online	http://vetmedcenter.com	Membership
VetProf: Veterinary Professionals List (Formerly: VETPLUS-L)		Online	http://www.vetprof.com	Subscription $30/yr

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TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
Find more discussion groups at: NetVet http://netvet.wustl.edu VetGate http://vetgate.ac.uk/ Topica: The Leader in Email Discussion Lists http://lists.topica.com/				
OSHA				
OSHAstuff.com [for Workplace Safety and Compliance]	Amboy Associates		http://www.oshstuff.com/	
Occupational Health and Safety Admin. (OSHA)	U.S. Dept. of Labor	Online	http://www.osha.gov/	
PET HEALTH				
VeterinaryPartner.com	Veterinary Information Network (VIN)	Online	http://veterinarypartner.com/	Free to all
Encyclopedia of Canine Veterinary Medical Information	VetInfo	Online	VetInfo: Dog Index http://www.vetinfo.com/dencyclopedia/deindex.html	
Encyclopedia of Felline Veterinary Medical Information	VetInfo	Online	http://www.vetinfo.com/cencyclopedia/ceindex.html	
Veterinary Information for Dog Owners	VetInfo	Online	http://www.vetinfo4dogs.com/	
Veterinary Information for Cat Owners	VetInfo	Online	http://www.vetinfo4cats.com/	
VetInfo Digest [monthly compilation of what's going on in veterinary health care]	VetInfo	E-mail	http://www.vetinfo.com/vetdigest.html	E-mail montly or print
VetMedCenter.com	VetMedCenter.com	Online	http://www.vetmedcenter.com	

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Other Selected Electronic Resources for Practicing Veterinarians

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TITLE / NAME	Publisher / Producer	Online	Source / Vendor	Access Method
PRACTICE MANAGEMENT				
Veterinary Economics' HospitalDesign.net	ADVANSTAR Veterinary Healthcare Communications	Online	http://www.hospitaldesign.net/	Free to all
The Exam Room	American Veterinary Medical Association and National Commission on Veterinary Economic Issues	Online	http://www.avma.org http://www.ncvei.org/	
MARKETLink	American Animal Hospital Association	Online	http://www.aahamarketlink.com/	Membership, includes: Compendium of Veterinary Products, MSDS, product listings.
Your Employees and the Law	U.S. Dept. of Labor	Online	http://www.dol.gov/elaws/firststep/	Free to all ; online access to labor laws ; can be customized to your practice
Small Business Administration	U.S. Small Business Admin.	Online	http://www.sba.gov/	Free to all ; offers e-learning modules
STATISTICAL SOURCES				
U.S. Agriculture Statistics (1995-2003)	U.S. National Agricultural Statistics Service (Beltsville, MD)	Online	http://www.usda.gov/nass/pubs/agstats.htm	May also be purchased in print form
Veterinary Market Statistics	Am. Vet. Med. Assoc. (Schaumburg, IL)	Online	http://www.avma.org/membshp/marketstats/default.asp	Selected statistics free online Purchase reports: U.S. Pet Demographics (2003); 2003 Economic Status of Veterinarians

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Appendix:

III. Other Selected Electronic Resources for Practicing Veterinarians

A. Title / Name

B. Publisher / Producer

C. Online

Internet - Online
CD-ROM

E. Source/Vendor for Electronic Full-Text

1. Vendor or aggregator

2. Associations or organizations

3. Publishers

G. Access Method for Electronic Full-Text

1. Free access to all on the Web

2. Free online access with registration

International Veterinary Information Service (IVIS)
http://www.ivis.org/

3. Free access with professional association/organization membership (Often by UserID and password)

Direct from publisher/source

Through an authorized vendor

4. Purchase