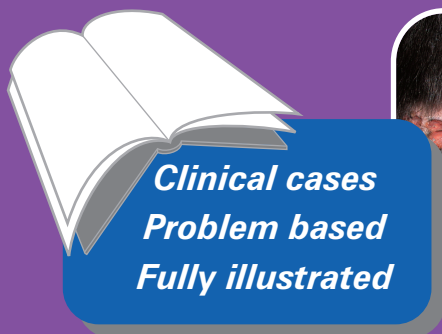


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Feline Infectious Diseases

Katrin Hartmann

Julie K Levy



Self-Assessment Color Review

Feline Infectious Diseases

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Preface

As a species, the cat is host to some of the oldest infectious diseases known to veterinary medicine as well as being involved at the forefront of emerging and newly discovered infections. Cats are victim to rapidly spreading pathogens and those that hide quietly within their own DNA. They have been implicated in zoonoses and the spread of infections to and from wildlife. As cats become increasingly important human companions around the world, the veterinarians enchanted by this species have developed reliable diagnostic approaches and exceptionally effective prevention and treatment strategies for many infections. Despite this, infectious diseases remain an important part of daily feline practice, either because the solutions do not yet exist or because some cats still remain outside the reach of veterinary care.

With this book, we provide an overview of feline infectious diseases in a case-based manner, the way clinicians encounter them in daily practice. We hope this practice-oriented approach motivates the reader to contemplate the cases and to reflect on how they might have managed each case.

The book was created for veterinary practitioners and veterinary students during their clinical rotations, to improve and practice their knowledge of infectious diseases. At the end of every case, questions for self-assessment by the reader are provided to test existing knowledge. The illustrations that accompany each case will help the reader to identify both classical and unique disease presentations.

We are very grateful for the expertise and hard work of all our co-authors. We would also like to thank Jill Northcott and the team at Manson Publishing for their patience and encouragement. Most of all we would like to thank our partners, friends, and colleagues in our teaching institutions for all their support and encouragement to turn this book into reality. We invite the readers to approach this book the way we approach each of our feline patients, as a series of mysteries awaiting our careful detective work in search of a happy outcome for our patients and the families that care for them. We hope that this book will inspire veterinarians to embrace the topic of feline infectious diseases and to contribute to the health and welfare of cats everywhere.

Katrin Hartmann & Julie Levy

Editor and contributor profiles

Editors



Katrin Hartmann

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Dr Hartmann graduated from the College of Veterinary Medicine at the LMU University of Munich in 1987, completed her doctoral thesis in 1990 and her habilitation thesis on the antiviral treatment of FIV infection in 1995. She stayed on as a Resident in small animal internal medicine, Clinical Instructor, and Assistant Professor at the Clinic of Small Animal Medicine at the University of Munich until 2001. From 2001 to 2003, she worked as an Associate Professor in the College of Veterinary Medicine, University of Georgia, USA. Since 2003, she has been Professor and Head of the Clinic of Small Animal Medicine at the LMU University of Munich, Germany. Her research is concentrated on infectious diseases in cats and dogs, with a special focus on virus infections in cats.



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Dr Levy graduated from the School of Veterinary Medicine at the University of California, Davis, USA, in 1989. She completed an internship at Angell Memorial Animal Hospital in 1990 followed by a residency in small animal internal medicine in 1993 and a PhD in 1997 at North Carolina State University. Her dissertation research focused on the immunopathogenesis of FIV infection. She is Director of Maddie's Shelter Medicine Program at the University of Florida. Dr Levy's research and clinical interests center on feline infectious diseases, neonatal kitten health, humane alternatives for cat population control, and immunocontraceptive vaccines for cats. She is the founder of Operation Catnip, with two university-based feral cat spay/neuter programs that have sterilized more than 45,000 cats since 1994.

Contributors



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Dr Barrs graduated from the University of Sydney in 1990 and returned in 1993 to complete a residency in infectious diseases and small animal medicine. She attained a Master's degree in infectious diseases in 1997 and achieved Fellowship of the Australian College of Veterinary Scientists in Feline Medicine in 2000. Dr Barrs is currently Co-director of the busy feline referral service at the Valentine Charlton

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Dr Barsanti graduated from the New York State College of Veterinary Medicine at Cornell University in 1974. She completed an internship at Auburn University in 1975 followed by a Master's degree in 1976. She completed her internal medicine residency at the University of Georgia in 1977 and joined the faculty. Her dissertation research focused on the interaction between canine heartworm disease and the kidney. Dr Barsanti is currently Josiah Meigs Distinguished Teaching Professor, Emerita in the Department of Small Animal Medicine and Surgery at the University of Georgia, USA. Her interests focus on urinary tract diseases of dogs

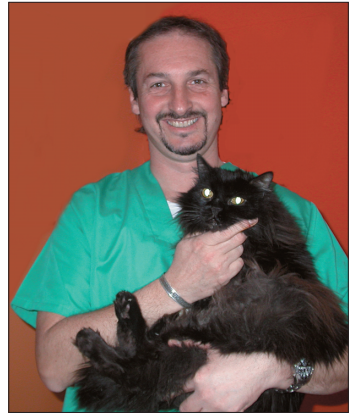
and cats and prostatic diseases in dogs.

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Dr Bo graduated from the College of Veterinary Medicine of Turin, Italy. From 1992 to 1994 he received a fellowship from the National Health Institute on the 'Evaluation of cats with FAIDS and its therapy'. In 1999, he completed his doctoral thesis in veterinary internal medicine. Currently he is a Lecturer at the College of Veterinary Medicine of Turin, Italy, sees patients in his private practice, and is President of the Italian Society of Feline Medicine.

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Dr Dietrich graduated from the College of Veterinary Medicine at the LMU University of Munich, followed by a doctoral thesis in ocular ultrasound at the University of Munich in 1996. She then completed a residency in veterinary ophthalmology at the University of Zurich, Switzerland in 2000. Dr Dietrich was a faculty member in the Department of Small Animal Medicine and Surgery at the University of Georgia, Athens, USA from 2001–2009. Her research interests focussed on feline and equine ophthalmology, glaucoma, and ocular ultrasound. Dr Dietrich is currently affiliated with the New York City Veterinary Specialists and lives in New York City.





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Dr Fischer graduated from the College of Veterinary Medicine at the LMU University of Munich in 1987. She completed her doctoral thesis in 1990 and a residency in neurology at University of Georgia, Athens, USA, in 1994. She completed her habilitation thesis on electrodiagnostic techniques in small animal neurology in 2000. Dr Fischer is currently Chief of the Neurology Service at the Clinic of Small Animal Medicine of the LMU University of Munich,

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Dr Hensel graduated from the School of Veterinary Medicine at the University of Bern, Switzerland, in 1996. He completed a doctoral thesis in 2000 and an internship at the School of Veterinary Medicine at the University of Zurich, Switzerland, in 2001. He then did a residency in dermatology with board certification in 2004 at the University of Georgia, where he is currently a faculty member in the Department of Small Animal Medicine and Surgery in Athens, USA. His main areas of interest are canine atopic dermatitis, allergy testing, and infectious diseases.

**Kate Hurley**

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Dr Hurley began her career as an animal control officer in 1989. After graduation from the School of Veterinary Medicine at the University of California in 1999, Dr Hurley worked as a shelter veterinarian in California and Wisconsin. In 2001, she returned to Davis to complete a residency in Shelter Medicine. Dr Hurley is currently the director of the Koret Shelter Medicine Program in Davis, USA. She loves shelter work because it has the potential to improve the lives of so many animals. Her interests include population health and infectious disease, with a particular emphasis on feline upper respiratory tract infections.



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Dr Malik graduated from the University of Sydney in 1981. He completed a PhD in neuropharmacology at the Australia National University, then returned to the University of Sydney for a residency in internal medicine. He remained there for 16 years in a variety of positions, including the Valentine Charlton Senior Lecturer position in Feline Medicine (1995 to 2002). Dr Malik is currently an Adjunct Professor in Veterinary Infectious Diseases at the University of Sydney, Australia, and a Senior

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Dr Mueller graduated from the College of Veterinary Medicine at the LMU University of Munich in 1985, and worked in private practice before completing a residency in dermatology at the School of Veterinary Medicine at the University of California, Davis, USA, in 1992. He worked in a private dermatology referral practice in Melbourne before joining the faculty at the College of Veterinary Medicine at Colorado State University in 1999. He completed

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Dr Mullin received her MS at the University of Manitoba, Canada in 1988 and her VMD from the University of Pennsylvania in 1995. After an internship at the Animal Medical Center in New York City, Dr Mullin worked for the Humane Society of New York in both their shelter and low-cost clinic. Dr Mullin is currently completing a residency program in shelter medicine at the University of California, Davis, USA. She is passionate about cats, and her interests include all aspects of animal sheltering with an emphasis on feline infectious diseases.



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Dr Scherk graduated from the Ontario Veterinary College in Guelph, Canada, in 1982. In 1995 she became board-certified in Feline Practice by the American Board of Veterinary Practitioners (ABVP). She practiced at Cat's Only Veterinary Clinic in Vancouver, Canada from 1986 to 2008. She is the North American editor for the *Journal of Feline Medicine and Surgery* and was the President of the American Association of Feline Practitioners (AAFP) for 2007. Her interests include analgesia, ethology, and geriatric internal medicine.





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Medicine at the LMU University of Munich, Germany. Her primary research interests focus on feline and canine respiratory tract disease, especially infectious diseases and feline asthma.

Classification of cases

Note: references are to case numbers.

ORGAN SYSTEMS

- Respiratory** 4, 9–11, 17–19, 25, 26, 39, 40, 42–44, 48, 52–54, 59, 79–81, 86–88, 92, 108, 109, 121, 122, 132–134, 136–138, 142–144, 149, 152, 174, 183, 184, 194–196
- Dermatological** 5, 13–15, 22–24, 30, 31, 35, 36, 46, 47, 49, 59, 70, 71, 75, 82, 83, 90, 91, 97, 102, 108, 109, 115, 124, 125, 129–131, 153–155, 160–163, 180, 181, 197–199
- Cardiovascular** 60–62, 110, 111, 116, 177, 180, 181
- Urological** 16, 20, 66, 100, 101, 106, 126, 127, 129, 130, 157–159
- Neurological** 1, 6, 7, 32–34, 38, 42–44, 76, 77, 85, 98, 99, 120, 123, 128, 135, 145, 156, 160, 161, 166, 167, 187, 190
- Orthopaedic** 107, 109
- Ophthalmological** 28, 29, 37, 69, 72, 78, 104, 105, 114, 162–164, 197–199
- Oral/gastrointestinal** 2, 3, 21, 41, 56–58, 63, 64, 67, 68, 84, 103, 117–119, 165, 178, 179, 186, 188, 189, 191, 193
- Systemic** 8, 9, 12–15, 17, 27, 45, 50, 51, 55, 73, 74, 86–89, 94–96, 112, 113, 139–141, 146–148, 150, 151, 168–173, 175–177, 182, 185, 191, 192

INFECTIONS

VIRUSES

- FIV** 25, 26, 46, 47, 63, 64, 67, 68, 157, 158, 166, 167, 171, 183, 185, 186, 191
- FeLV** 16, 33, 34, 69, 150, 151, 159, 168–170
- FCoV12** 32, 50, 51, 73, 74, 76–78, 94–96, 135, 148, 172, 173
- FPV** 2, 3, 38, 56–58, 84, 117–119
- FHV** 37, 184
- FCV** 17, 93, 184
- Influenza** 86–88
- Rabies** 190

BACTERIA

- Respiratory *Mycoplasma* spp.** 18, 19, 132
- Haemotrophic *Mycoplasma* spp.** 8
- Bartonella* spp.** 147
- Bordetella bronchiseptica*** 52–54, 136, 137
- Mycobacteria* spp.** 30, 31, 46, 47, 49, 97, 140, 141, 154, 155, 174
- Leptospira* spp.** 45
- Botulism** 120
- Borrelia burgdorferi*** 107
- Tetanus** 1, 85, 128, 145, 187
- Helicobacter* spp.** 21, 41, 165
- Nocardia* spp./*Actinomyces* spp.** 22, 23, 79, 80, 92, 138

Chlamydophila felis 28, 29, 164
Other bacteria 4, 6, 7, 13–15, 66, 75, 89, 98–101, 107, 112, 113, 126, 127, 167,
178, 179, 192, 193

PARASITES

Leishmania spp. 129–131, 197–199
Babesia spp. 27
Cytauxoon felis 182
Toxoplasma gondii 72, 81, 104, 105, 139, 146, 152, 166, 167, 194–196
Giardia lamblia 103
Tritrichomonas foetus 188, 189
Lungworm 121, 122, 133, 134, 142–144, 183
Heartworm 60–62, 110, 111, 116, 177, 180, 181
Otodectes cynotis 5, 35, 36
Other parasites 24, 114, 115

FUNGI

Cryptococcus spp. 25, 26, 42–44, 48, 108, 109, 160–163
Aspergillus spp. 39, 40
Histoplasmosis capsulatum 10, 11
Sporothrix schenckii 82, 83, 124, 125
Microsporum canis 70, 71, 90, 91, 102
Other fungi 36, 153

Abbreviations

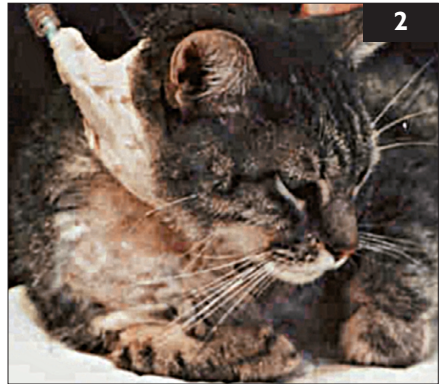
ACE	angiotensin-converting enzyme	GMS	Gomori methenamine silver
AIHA	autoimmune hemolytic anemia	HARD	heartworm-associated respiratory disease
ALP	alkaline phosphatase	H&E	hematoxylin and eosin
ALT	alanine aminotransaminase	HIV	human immunodeficiency virus
ANA	antinuclear antibody	IBD	inflammatory bowel disease
AST	aspartate transaminase	ID	intra dermal
AZT	3'-azido-2',3'-dideoxythymidine (zidovudine)	IFA	immunofluorescent antibody
BAL	bronchoalveolar lavage	IM	intramuscular
BCG	Bacille Calmette-Guérin	IN	intranasal
BCS	body condition score	IOP	intraocular pressure
bpm	beats/ breaths per minute	ITP	immune-mediated thrombocytopenia
CD	cluster determination	IV	intravenous
CK	creatinine kinase	LDH	lactate dehydrogenase
CNS	central nervous system	LPS	lipopolysaccharide
CPV	canine parvovirus	MCV	mean cell volume
CSD	cat-scratch disease	MLV	modified live virus
CSF	cerebrospinal fluid	MRI	magnetic resonance imaging
CT	computed tomography	PAS	periodic acid-Schiff
DIC	disseminated intravascular coagulation	PCR	polymerase chain reaction
DNA	deoxyribonucleic acid	PLR	pupil light reflex
DTM	dermatophyte transport medium	PO	oral
ELISA	enzyme-linked immunofluorescent assay	PT	prothrombin time
EPO	erythropoietin	PTT	partial thromboplastin time
FCV	feline calicivirus	RBC	red blood cell
FCoV	feline coronavirus	(r)RNA	(ribosomal) ribonucleic acid
FDP	fibrin degradation product	RT-PCR	reverse transcription polymerase chain reaction
FeLV	feline leukemia virus	SC	subcutaneous
FeSV	feline sarcoma virus	SLE	systemic lupus erythematosus
FHV	feline herpesvirus	SPA	<i>Staphylococcus</i> protein A
FIP	feline infectious peritonitis	TNR	trap-neuter-return (program)
FIV	feline immunodeficiency virus	TPN	total parenteral nutrition
FPV	feline panleukopenia virus/feline parvovirus	UMN	upper motor neuron
FUO	fever of unknown origin	UPC	urine protein to creatinine ratio
G-CSF	human recombinant granulocyte colony-stimulation factor	UTI	urinary tract infection
		VS-FCV	virulent strain feline calicivirus
		WBC	white blood cell

1 A 4-year-old castrated male domestic shorthair cat was seen because of a 7-day history of rigidity of the left thoracic limb (1). Sometimes, episodes of severe muscle spasm were superimposed. Forelimb rigidity had developed over a 72-hour period, but was subsequently nonprogressive. Otherwise, the cat had seemed quite well. It was eating and drinking normally, and could move around the house. Apart from the affected limb, the general physical and neurologic examinations were unremarkable. There was a small scab below the left elbow. The limb had markedly increased muscle tone and an increased triceps reflex, and there was normal sensation in the left front paw.



- i. What are the differential diagnoses?
- ii. What additional evaluation is indicated?
- iii. Are radiographs of the spine and a myelogram likely to be helpful in this situation?
- iv. Are electrodiagnostic studies likely to be useful?

2 A 2-year-old castrated male domestic shorthaired cat (2) was seen because of acute vomiting for 3 days. The cat had been obtained from a shelter 1 month previously and lived both indoors and outdoors. At presentation, the only preventative care the cat had received was one vaccination against rabies. Physical examination revealed depression, lethargy, hypersalivation, about 7% dehydration and pain on abdominal palpation. The body temperature was 40.9°C.



Blood profile	Results
RBC	$10.4 \times 10^{12}/l$
Platelets	$156 \times 10^9/l$
WBC	$0.40 \times 10^9/l$
Mature neutrophils	$0.12 \times 10^9/l$
Lymphocytes	$0.12 \times 10^9/l$

- i. What is the most likely diagnosis in this cat?
- ii. What tests should be done next?

I, 2: Answers

1 i. The only likely diagnosis in a cat with this presentation is localized (or local) tetanus.

ii. Local tetanus is a clinical diagnosis, and tetanus is the only infectious disease that is usually diagnosed just based on the clinical findings. In most cases, there is insufficient tetanus toxin present in the circulation for mouse inoculation studies. In early cases it may be possible to culture *Clostridium tetani* from the wound using meticulous anaerobic culture techniques. The presence of a wound also lends strong support to a diagnosis of local tetanus, but not all affected animals have a detectable wound. Localized tetanus occurs in cases of minimal toxin elaboration, such that when the toxin is transported retrograde up the peripheral nerves, there is only enough to interfere with inhibitory neurotransmitter release in the motor neuron pools of the affected limb.

iii. Radiographs of the spine and myelography are unlikely to provide any useful diagnostic information in this cat.

iv. Electromyography shows persistent motor unit discharges even under deep anesthesia, confirming the clinical observation of increased activity in motor nerve axons subserving the affected limb, but is usually not necessary to confirm the diagnosis.

2 i. In young animals with inadequate vaccination and worming histories, the most common causes of gastrointestinal disease are: (1) infectious, (2) parasitic, and (3) dietary (food intolerance, ingestion of noxious substances and gastrointestinal foreign bodies).

In this young cat with fever and severe leukopenia, feline panleukopenia virus (FPV) infection is the most likely differential diagnosis. The presence of a fever and leukopenia make inflammatory bowel disease unlikely. A foreign body and peritonitis should also be considered, but peritonitis seems less likely in the absence of an inflammatory leukogram. Extra-gastrointestinal disorders are less likely in a young previously healthy animal and could be ruled out with a serum biochemical panel.

ii. Further tests should include: (1) testing for FPV (fecal antigen test), and (2) fecal examination (flotation, direct smear).

If the FPV antigen test is negative, abdominal imaging studies could be performed. A serum biochemical profile is indicated to rule out metabolic causes of vomiting and to guide fluid therapy. Fecal antigen testing for giardiasis and culture for salmonellosis should be considered. An upper gastrointestinal radiographic contrast study should be considered only if foreign body or mechanical obstruction is strongly suspected. However, this carries a risk of vomiting and aspiration. Biopsy (*via* upper gastrointestinal endoscopy or exploratory laparotomy) should only be considered if the cat does not respond to medical care.



3 Case 3 is the same cat as case 2. A fecal antigen test for parvovirus is negative (3).

- i. Does this rule out FPV infection?
- ii. What causes feline parvovirus and how else may it be diagnosed?



4 A 7-year-old spayed female domestic shorthair cat was seen because of a 3-month history of chronic mucopurulent nasal discharge (4). The cat had received two 10-day courses of antibiotics (amoxicillin and enrofloxacin). During antibiotic treatment nasal discharge became less severe, but it relapsed afterwards. A sample of the nasal discharge had been submitted for bacterial culture and sensitivity testing, and heavy growth of *Pasteurella multocida* was found. Sensitivity testing indicated resistance to amoxicillin and cephalexin. The cat lived indoors, and vaccines were current. Besides the clinical signs related to the nose, the cat was unremarkable. Physical examination revealed purulent nasal discharge from both nares, a slight inspiratory nasal stridor, and slightly enlarged mandibular lymph nodes.

- i. What is the most likely reason for nasal discharge?
- ii. How useful is a bacterial culture of nasal discharge?
- iii. What further tests could be performed?
- iv. What are the possible treatment options?

3, 4: Answers

3 i. A negative fecal antigen test result does not rule out FPV infection. Viral shedding is brief and intermittent, and negative results may occur if the test is performed after more than 5–7 days of illness. Viremia occurs before fecal shedding, but negative results are also possible if fecal antigen tests are performed early during clinical illness (e.g. before the onset of diarrhea). Also, positive results are possible following MLV vaccination in healthy animals.

ii. Cats may be infected by FPV or canine parvoviruses (CPV-2a and CPV-2b). Both may cause clinical signs of panleukopenia. Kits that test for fecal canine parvovirus antigen may detect both wild and vaccine strains of both viruses. PCR testing of blood or bone marrow during early infection (viremic phase) may be positive for FPV prior to fecal antigen tests. Parvoviral infection may also be diagnosed *via* fecal electron microscopy, virus isolation, or immunofluorescence staining. Histopathologic examination and immunofluorescence testing are usually carried out in animals that have died. Intestinal biopsies are rarely obtained in acute parvoviral gastroenteritis, as cats are not stable enough to undergo biopsy initially, and later recover with supportive care. Antibody tests are usually negative when the animals are presented, due to the short incubation period. In this case, parvovirus infection was diagnosed by electron microscopy. The cat was treated symptomatically and recovered within a week.

4 i. Diseases that have to be considered are: (1) neoplasia, (2) lymphoplasmacytic rhinitis, (3) trauma, (4) foreign body, (5) dental problems, (6) nasopharyngeal polyps, (7) infectious diseases (e.g. FHV, FCV, cryptococcosis, aspergillosis), and (8) secondary bacterial infections.

ii. Bacterial cultures of nasal discharge are not helpful in establishing a diagnosis. Multiple bacterial organisms can be cultured from the nose of healthy cats; these usually cause secondary infection in chronic nasal diseases. To treat the problem successfully, diagnosis and treatment of the underlying primary disease should be attempted.

iii. The oral cavity should be examined for signs of dental disease, masses deviating the hard or soft palate, or polyps protruding into the nasopharynx. A complete blood count, biochemistry profile, and urinalysis should be performed to detect systemic disease causing immunosuppression or organ dysfunction. Nasal cytology could be performed to look for *Cryptococcus* spp., and a cryptococcal antigen titer could be obtained. To localize the disease process, involvement of the lower airways and sinuses should be investigated. CT or radiographs of the nasal cavity and paranasal sinuses should be followed by rhinoscopy to visualize the disease process and to obtain biopsy samples for histopathology and fungal culture.

iv. Firstly, the underlying disease process should be addressed. If this problem can be treated, secondary bacterial infection should resolve with a broad-spectrum antibiotic given for 2–3 weeks. If the underlying problem cannot be treated successfully, antibiotic pulse therapy or long-term treatment with an antibiotic may be helpful.