

6

Chinchilla

Introduction

There are two species of chinchillas: the short-tailed chinchilla, *C. chinchilla*, and the long-tailed chinchilla, *C. laniger* (a.k.a. *C. lanigera*). They belong to the order Rodentia, suborder Hystricognathi (which includes guinea pigs), and family Chinchillidae. They are native to the arid mountains of the Andes, occupying burrows and clefts in rocks. Their original native range once extended to Bolivia, Peru, and Chile. Short-tailed chinchillas occupied the southern portions of that range but are now extremely rare in the wild. Wild *C. laniger* are also substantially reduced in number and are found only in Peru. Both wild species are listed as endangered. A close relative of the chinchilla is the degu (*Octodon degus*). These small rodents occupy scrublands of central Chile and have also been acquired for research and subsequently as pets. Very little is known about degu diseases, but they likely share disorders in common with chinchillas.

Domestic chinchillas are derived from *C. laniger*, although some believe they may have hybrid (*C. laniger* x *C. chinchilla*) origins. Indigenous people used chinchilla fur for making clothing and blankets, and to the ultimate misfortune of chinchillas, chinchilla pelts became a popular export commodity for the fur trade. Between 1898 and 1910, Chile exported around 7 million pelts per year, resulting in the near extinction of both species. In 1923, a breeding colony of 11 *C. laniger* was established in Southern California, from which all domesticated chinchillas in the United States are derived. Today, domestic chinchillas are maintained commercially for pelt production, as laboratory animals, and increasingly as pets. Selective breeding has yielded several coat color variants.

Behavioral, Physiologic, and Anatomic Features

Behavioral Features

In their native habitat, chinchillas live in herds of up to 100, occupying burrows and clefts in rocks. In captivity,

they can live 10 to 20+ years. They are monogamous, generally giving birth to one to three kits (up to six) after a gestation period of around 111 days (range 105–120 days). The short-tailed chinchilla has a gestation period of around 128 days. Males are called “bucks,” females “does,” and infants “kits.” Kits of both species are very precocious at birth. Females do not build nests before parturition and wean their young around 8 weeks of age. They reach sexual maturity around 8 months of age, although they may breed at younger ages. They are crepuscular and nocturnal, and sleep during the day, often with their eyes wide open. They do not like to be restrained and express their displeasure by jumping (up to 6 feet), climbing, urine spraying, biting, and vocalization. An effective escape mechanism is a syndrome called “fur slip” in which patches of fur are exfoliated where chinchillas are held, resulting in focal alopecia. Mature males may fight, and estrus or post-partum females may become aggressive, especially toward males. Chinchillas maintain the health of their luxuriant fur by partaking in dust baths, which must be provided for their well-being.

Physiologic Features

Unlike guinea pigs, chinchillas do not require dietary sources of vitamin C. Like rabbits and guinea pigs, chinchillas absorb calcium through their intestine in proportion to the amount in the diet. Unlike rabbits and guinea pigs, they do not excrete excess calcium in their urine but rather through their intestine. This adaptation is likely due to their arid home range. Although they are generally provided water in captivity, they can obtain sufficient water from their natural diet, with efficient retention by the kidneys. Chinchillas engage in cecotrophy and require dietary fiber to facilitate gastrointestinal function.

Anatomic Features

Female chinchillas are larger than males. Chinchillas have four toes on all four feet. They are notable for their

extremely dense fur, which effectively minimizes ectoparasitism. Likely to aid nocturnal navigation, they have long vibrissae and prominent ears with very large tympanic bullae, which has favored them as models for otitis research. Eyes are large, with densely pigmented irises and vertically oriented pupils to accommodate high-altitude ultraviolet exposure. Chinchilla incisors and cheek teeth are elodont, and cheek teeth are hypsodont in character, with the mandibular arcade being wider than the maxillary arcade (anisognathism). Their dental formula is I1/1, C0/0, P1/1, M3/3.

Females have three pairs of nipples: two lateral thoracic pairs and one inguinal pair. The lateral thoracic nipples facilitate nursing in a resting position. The female urethra opens on a prominent urethral cone, which can be misconstrued as a penis. Males lack nipples and mammary glands. They also lack a true scrotum, which is barely visible externally. Like other rodents, they have a full complement of accessory sex glands and form copulatory plugs upon ejaculation. Like guinea pigs, female chinchillas have a vaginal closure membrane, which opens during estrus, parturition, and uterine diseases. They have a bicornuate uterus with two complete cervical canals. Placentation is discoidal and hemochorial-labyrinthine, with a subplacenta like the guinea pig. A common finding in rodents with hemochorial placentation during pregnancy and postpartum is the invasion of trophoblasts into maternal tissue, including dissemination or embolism (“deportation”) to distant organs, particularly the pulmonary vasculature (Figure 6.1).

It is apparent that further studies are needed to better define chinchilla anatomy and physiology. Chinchilla

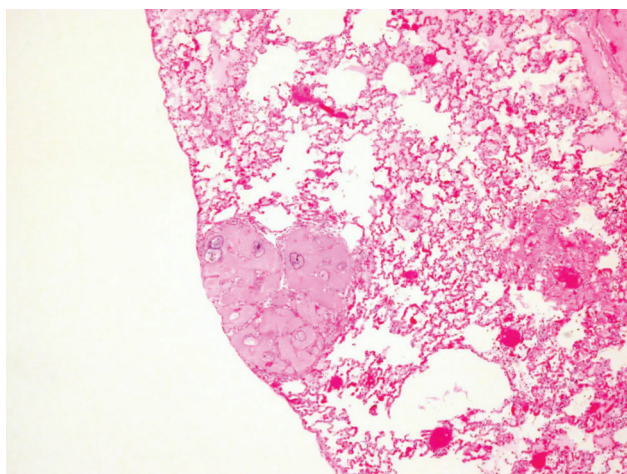


Figure 6.1 Trophoblast embolus in the lung of a chinchilla. “Deportation” of trophoblasts is common in rodents and rabbits with hemochorial placentation. *Source:* Brian Caserto, Charles River Laboratories.

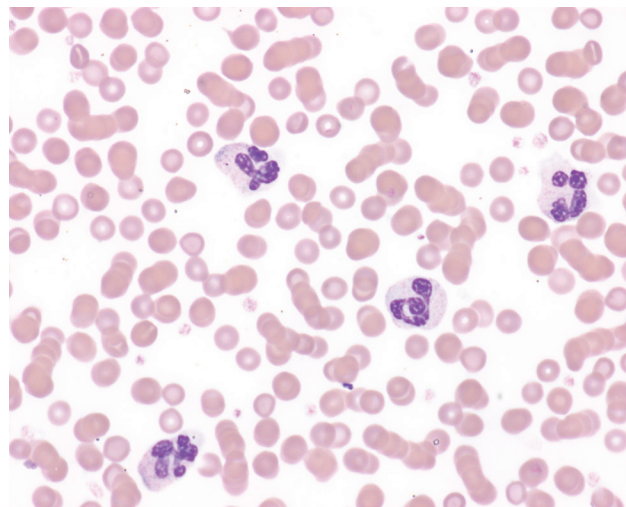


Figure 6.2 Peripheral blood smear of a normal chinchilla. Note the multiple neutrophils with typical segmented nuclei. *Source:* Melanie Ammersbach, Veterinary Medical Teaching Hospital, University of California, Davis.

neutrophils (not heterophils) are reported to have hyposegmented nuclei, resulting in the claim that they represent Pelger–Huet anomaly. In addition, it is also often cited that chinchilla neutrophils lack myeloperoxidase, based upon an unsubstantiated statement carried forward from a publication by Riggs and Mitchell (2008). On the contrary, nuclear segmentation in neutrophils is routinely observed (Figure 6.2). Furthermore, myeloperoxidase function and amount have been extensively studied in the chinchilla model of otitis. Chinchillas produce equivalent amounts of functional myeloperoxidase as guinea pigs and rabbits. In addition, many reviews of chinchilla anatomy state that chinchillas lack a right coronary artery, although a recent study demonstrated that they do indeed have a right coronary artery. They lack internal carotid arteries, and the arterial supply to the brain is provided by vertebral arteries merging with basilar arteries to form the arterial circle. A similar configuration is present in other hystricomorphs.

Like guinea pigs, chinchillas have a palatal ostium (an opening in the soft palate that connects the oropharynx with the pharynx), are unable to vomit, and have a gastrointestinal tract that is conducive to hind-gut fermentation and cecotrophy. The cecum is located on the left side of the abdomen. It has two segments, including a coiled sacculated segment and a tubular segment. The cecum holds approximately 23% of the intestinal digesta, unlike guinea pig ceca that contain around 65% of digesta, and rabbits around 55%. In contrast, chinchillas possess a very long small intestine and colon. Guinea pigs and chinchillas utilize a colonic furrow in the proximal colon as a separation mechanism that returns bacteria and nitrogen-rich digesta back into the cecum.

General References

- Dall, J. (1963) Disease of the chinchilla. *Journal of Small Animal Practice* 4:207–212.
- Garcia, M.A., Barcelo, A.M., Nadeu, C.B., & Jekl, V. (2021) Respiratory diseases in guinea pigs, chinchillas and degus. *Veterinary Clinics: Exotic Animal Clinics* 24:419–457.
- Graham, J.E. & Mans, C. (2021) Chinchillas. In: *Exotic Animal Emergency and Critical Care Medicine* (eds. J.E. Graham, G.A. Doss, & H. Beaufreire), pp. 310–329. Wiley.
- Kennedy, A. (1952) *Chinchilla Diseases and Ailments*. Fur Trade Journal of Canada, Toronto, Ontario. Reprinted 2021 by Thomson Press, India.
- Kraft, H. (1987) *Diseases of Chinchillas*. THF Publications.
- Riggs, S.M. & Mitchell, M.A. (2008) Chinchillas. In: *Manual of Exotic Pet Practice*, 1st edn (eds. M. Mitchell & T.N. Tully Jr.), Chapter 18, pp. 474–492. Saunders.
- Lucena, R.B., Giaretta, P.R., Tessele, B., Figuera, R.A., Kommers, G.D., Irigoyen, L.F., & Barros, C.S.L. (2012) Doencas de chinchillas (*Chinchilla lanigera*). *Pesquisa Veterinaria Brasileira* 32:529–535.
- Mans, C. & Donnelly, T.M. (2020) Chinchillas. In: *Ferrets, Rabbits, and Rodents. Clinical Medicine and Surgery*, 4th edn (eds. K. Quesenberry, D.J. Orcutt, C. Mans, & J.W. Carpenter), pp. 298–322. Elsevier.
- Martel, A. & Donnelly, T. (2020) Update on diseases of chinchillas: 2013–2019. *Veterinary Clinics: Exotic Animal Practice* 23:321–335.
- Martino, P.E., Bautista, E.L., Gimeno, E.J., Stanchi, N.O., & Radman, N.E. (2017) Fourteen-year status report of fatal illnesses in captive chinchilla (*Chinchilla lanigera*). *Journal of Applied Animal Research* 45:310–314.
- Reavill, D. (2014) Pathology of exotic companion mammal gastrointestinal system. *Veterinary Clinics: Exotic Animal Practice* 17:145–164.

Bibliography for Behavioral, Physiologic, and Anatomic Features

- Bjornhag, G. & Snipes, R.L. (1999) Colonic separation mechanism in lagomorph and rodent species—a comparison. *Zoosystematics and Evolution* 75:275–281.
- Benirschke, K. & Kaufmann, P. (2011) Chinchilla (*Chinchilla laniger*). *Comparative Placentation*, ucsd.edu.
- Kawana, M., Kawana, C., Yokoo, T., Quie, P.G., & Giebink, G.S. (1991) Oxidative metabolic products released from polymorphonuclear leukocytes in middle ear fluid during experimental pneumococcal otitis media. *Infection and Immunity* 59:4084–4088.
- Kuchinka, J., Radzimirska, M., Banas, D., Nowak, E., & Szczurkowski, A. (2023) The right coronary artery in the heart of chinchilla (*Chinchilla laniger* Molina). *Veterinary Research Communications* 47:745–752.

Perez, W., Vazquez, N., & Jerbi, H. (2011) Gross anatomy of the intestine and their peritoneal folds in the chinchilla (*Chinchilla lanigera*). *Journal of Morphological Sciences* 28:180–183.

Siegal, A. & Walton, R.M. (2020) Hematology and biochemistry of small mammals. In: *Ferrets, Rabbits, and Rodents. Clinical Medicine and Surgery*, 4th edn (eds. K. Quesenberry, D.J. Orcutt, C. Mans, & J.W. Carpenter), pp. 569–582. Elsevier.

Stan, F. (2014) Anatomical particularities of the cecum in rabbits and chinchillas. *Bulletin UASVM Veterinary Medicine* 71:406–412.

Viral Infections

There is a paucity of information on viral infections in chinchillas, although anecdotal reports of outbreaks of upper respiratory disease among farmed chinchillas suggest a viral causation. Interstitial pneumonia of unknown etiology is a common finding in the lungs of chinchillas with respiratory illness. Chinchillas are experimentally susceptible to influenza viruses, and the likelihood of natural infection, as in guinea pigs, is high. There is no doubt that viruses also play a role in enteric disease outbreaks, but appropriate investigation is needed. The monkeypox virus has been detected in tissues of a chinchilla in association with a human case, and calicivirus has been detected in a chinchilla with bacterial pneumonia without further analysis. Chinchillas are often listed as hosts of lymphocytic choriomeningitis virus, but this is probably due to “guilt by association” with other rodents as sources of human infection. They are probably susceptible to infection but are not carriers of the virus. Several public health departments in the United States have listed rare cases of rabies in pet chinchillas.

Herpes Virus

Herpes simplex virus encephalitis has been described in pet chinchillas. One case described seizures before death, with nonsuppurative meningitis, polioencephalitis, neuronal necrosis, and intranuclear inclusion bodies, particularly in the brain stem and cerebral cortices. In addition, the animal had keratitis, uveitis, retinitis, and optical neuritis in both eyes, suggesting that the eyes were the point of viral entry. There was also a purulent rhinitis with focal mucosal erosions and intranuclear inclusions. A less detailed report on a dead chinchilla noted necrosis and inclusion bodies in the brain, spleen, and adrenal glands. Feline herpes virus 1 (FHV-1) infection has also been documented by PCR/sequencing in nasopharyngeal swabs of farmed chinchillas without clinical signs.

Bibliography for Viral Infections

- Goudas, P. (1970) Spontaneous herpes-like viral infection in a chinchilla (*Chinchilla laniger*). *Journal of Wildlife Diseases* 6:175–179.
- Kulesh, D.A., Loveless, B.M., Norwood, D., Garrison, J., Whitehouse, C.A., Hartmann, C., Mucker, E., Miller, D., Wasieloski, L.P., Huggins, J., Huhn, G., Miser, L., Imig, C., Martinez, M., Larsen, T., Rossi, C.A., & Ludwig, G.V. (2004) Monkeypox virus detection in rodents using real-time 3'-minor groove binder TaqMan assays on the Roche LightCycler. *Laboratory Investigation* 84:1200–1208.
- Shi, L., Huang, S., Lu, Y., Su, Y., Guo, L., Guo, L., Xie, W., Li, X., Wang, Y., Yang, S., Chai, H., & Wang, Y. (2022) Cross-species transmission of feline herpesvirus 1 (FHV-1) to chinchillas. *Veterinary Medical Science* 8:2532–2537.
- Wohlsein, P., Thiele, A., Fehr, M., Haas, L., Henneicke, K., Petzold, D.R., & Baumgartner, W. (2002) Spontaneous human herpes virus type 1 infection in a chinchilla (*Chinchilla lanigera f. dom.*). *Acta Neuropathologica* 104:674–678.

Bacterial Infections

Chinchillas are susceptible to a plethora of bacterial diseases, particularly enteritis (*Clostridium perfringens*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella enteritidis*, *Staphylococcus aureus*, and *Yersinia* spp.) and pneumonia (*Bordetella bronchiseptica*, *Klebsiella pneumoniae*, *Listeria monocytogenes*, *Pasteurella multocida*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Streptococcus* spp.). In addition, most of these bacterial pathogens cause septicemic disease and several cause localized infections. Simultaneous multiple infections are often found, particularly in enteritis cases. As with viral infections, details are scant for several of these pathogens, including their actual prevalence among chinchilla populations. An attempt has been made to include all bacteria associated with disease in chinchillas, but better documentation is needed for many of these pathogens. In addition, many of these agents pose a zoonotic risk to humans.

Bordetella bronchiseptica

Bordetella bronchiseptica is probably common, particularly among pet chinchillas. It can be associated with rhinitis, conjunctivitis, otitis, and pneumonia, although subclinical carriers or mildly infected animals are likely. Pneumonia is characterized as a fibrinopurulent bronchopneumonia (Figures 6.3 and 6.4), similar to lesions in guinea pigs. Abundant fibrin is a hallmark feature of the lung pathology.

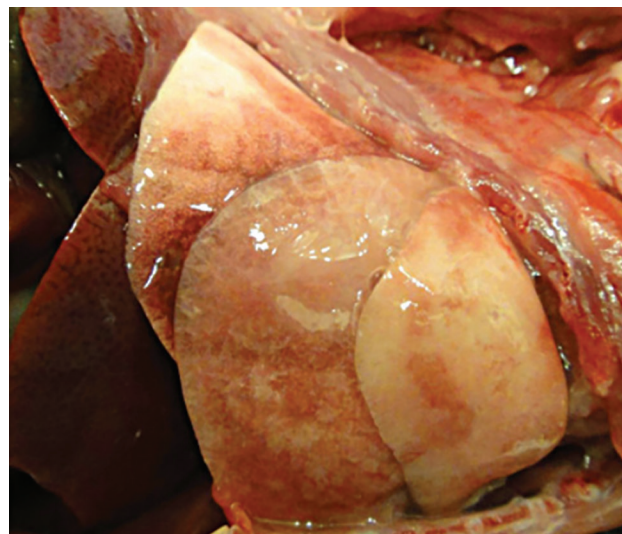


Figure 6.3 Acute bronchopneumonia in a chinchilla due to *Bordetella bronchiseptica*. Source: The Joint Pathology Center (JPC)/United States Military/conference 18-2014, case 0420150211.

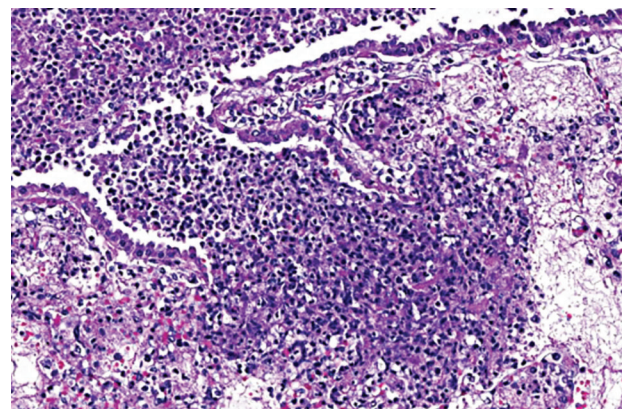


Figure 6.4 Acute fibrinopurulent bronchopneumonia in a chinchilla due to *Bordetella bronchiseptica*. Note the abundant fibrin that is typical with *Bordetella* pneumonia. Source: The Joint Pathology Center (JPC)/United States Military/conference 18-2014, case 0420150211.

Campylobacter lanienae

Campylobacter lanienae has been documented by PCR/sequencing and isolation in the cecum, colon, and feces of subclinical juvenile chinchillas that had a high prevalence of gastric ulcers, lymphoplasmacytic gastroenteritis, and typhlocolitis. No correlation of colonization with lesion severity was noted, so it was not likely to be the etiology of the enteric lesions.

Corynebacterium sp.

Chinchillas on several farms have been found to be infected with an unspiciated *Corynebacterium* (*C. kutscheri*,

Trueperella pyogenes). Affected animals had abscesses on the intestinal wall and fibrin/fibrous adhesions of abdominal organs, resulting in bowel obstruction and tympany. Infection was spread among the affected farms by the lax exchange of animals and equipment.

Clostridium perfringens

Clostridium perfringens toxinotypes A, B, and D have all been associated with sudden death and enterotoxemia in chinchillas. Toxinotypes are identified based upon the production of four major toxins, alpha (CPA), beta (CPB), epsilon (ETX), and iota (ITX). Toxinotype A produces CPA, type B produces CPA, CPB, and ETX, and type D produces CPA and ITX, although the production of up to 16 toxins in various combinations add to the pathogenicity of these isolates.

Enterotoxemia occurs most commonly in young chinchillas between 2 and 4 months of age. Animals may present with acute diarrhea and rectal prolapse before death. The intestine is grossly congested, hemorrhagic, and dilated (Figure 6.5). Lesions usually consist of superficial to deep mucosal epithelial necrosis with relative sparing of crypts, edema, hemorrhage, and inflammation in the large intestine (Figure 6.6). Aggregates of rod-shaped bacteria are present in the necrotic mucosa and lamina propria. Pulmonary edema and hepatic lipidosis may also be present. Infection with *Clostridioides difficile* has not been reported in chinchillas. Aside from spontaneous cases of enterotoxemia, treatment with a variety of antibiotics, including penicillins, cephalosporins, clindamycin, erythromycin, and lincomycin, can result in so-called “antibiotic toxicity,” as in other rodents and rabbits. Causative antibiotics belong among the “PLACE” list...penicillin,



Figure 6.5 Necrohemorrhagic enteritis in a chinchilla due to *Clostridium perfringens* type B. The intestine is distended with gas and bloody fluid, and serosa is markedly hyperemic. Note also hepatic lipidosis. Source: Lucena et al. (2011)/The Scientific Electronic Library Online (SciELO)/CC BY 4.0.

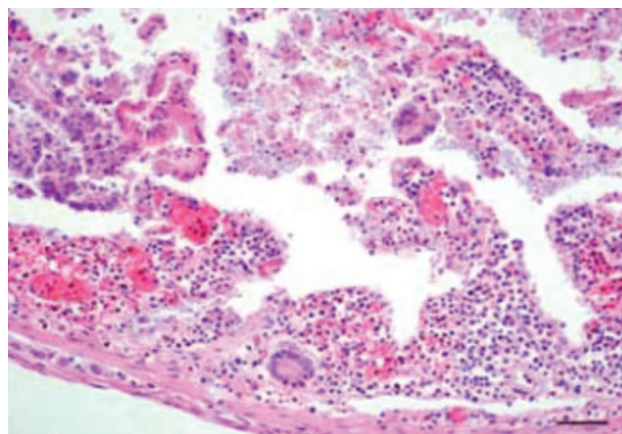


Figure 6.6 Necrotizing enteritis of the small intestine of a chinchilla due to *Clostridium perfringens* type B. The necrotic mucosal epithelium has exfoliated, and there is hemorrhage and leukocytic infiltration in the lamina propria. Source: Lucena et al. (2011)/The Scientific Electronic Library Online (SciELO).

lincomycin, ampicillin/amoxicillin, clavamox/clindamycin, and erythromycin...and are not advised for use in chinchillas.

Escherichia coli

As in other rodents and rabbits, *Escherichia coli* is not typically found in the intestine of normal chinchillas, and its presence signals dysbiosis. Overgrowth of *E. coli* often accompanies and contributes to enteropathies caused by other pathogens in chinchillas. Pathogenic strains of *E. coli* are among the most common causes of primary enteritis in chinchillas and can be isolated in pure aerobic cultures from affected animals. These are usually attaching and effacing *E. coli* (AEEC) that produce a lesion involving intimate adherence of bacteria to intestinal epithelium. This process involves the destruction of microvilli and the reorganization of actin-rich pedestals, mediated primarily through the bacterial intimin gene (*eae+*). Devastating outbreaks of enteritis, with 70% mortality in multiple chinchilla herds, have been reported. Some AEEC isolates are classified as Enterohemorrhagic *E. coli* (EHEC), which produce a shiga toxin that damages microvascular endothelium. As a result, the enteritis is hemorrhagic in character, resulting in bloody diarrhea, in addition to mucosal necrosis. EHECs tend to produce a hemolytic uremic syndrome and renal failure, but this has not been documented in chinchillas. The other type of AEEC consists of Enteropathogenic *E. coli* (EPEC) strains, which cause necrotizing enterocolitis and “non-bloody” diarrhea.

In one survey among farmed chinchillas, both EHEC and EPEC strains were documented. The enterotoxemia is often accompanied by intestinal tympany (Figure 6.7). One case report of a laboratory chinchilla was well documented.



Figure 6.7 Severe *Escherichia coli* typhlocolitis with tympany. Source: Martino et al. (2017)/Taylor & Francis Group/CC BY 4.0.

The animal had acute neutrophilic enteritis with Gram-negative bacteria attached to the apical surfaces of ileal villus epithelium. The colon had dilated crypts containing neutrophils, cellular debris, and mucin, and bacteria were found attached to the brush border of the surface mucosa. Evidence of septicemia included multifocal small areas of gastric mucosal necrosis, suppurative tubulonephritis, lymphocytolysis in the thymus, and depletion of lymphoid tissue in spleens. The animal also had marked hepatic lipidosis, resulting in hepatoencephalopathy. *E. coli* was isolated from the kidney and spleen. Metritis can also be due to *E. coli* infection.

Helicobacter sp.

So far, *Helicobacters* have not been found in chinchillas, except in a single case of *H. pylori* detection by PCR/sequencing in the gastric mucosa of a chinchilla with a gastric adenocarcinoma.

Klebsiella pneumoniae

Gastroenteritis and pneumonia, as well as septicemia, have been attributed to *Klebsiella pneumoniae* in farmed chinchillas. One outbreak in farmed chinchillas was characterized by pulmonary congestion and consolidation, hydrothorax, cardiac enlargement, gastroenteritis, and petechial hemorrhages on the kidneys. Pulmonary alveoli were filled with serous cellular exudate, and renal lesions included medullary hemorrhage and tubular necrosis. Intestinal changes were not described, despite the presence of gastroenteritis. Another survey of infections in farmed chinchillas attributed *K. pneumoniae* to gastroenteritis and pneumonia. One review of chinchilla diseases stated that *K. pneumoniae* was a common cause of enteritis and septicemia in young chinchillas.

Leptospira interrogans

Natural cases of leptospirosis in chinchillas due to *Leptospira interrogans* serovars *icterohemorrhagica* and *pomona* have been documented, but pathology was not described. It is likely that infection is restricted to captive chinchillas because the arid habitat of wild chinchillas is not conducive to *leptospira* exposure. Experimental infection has shown that chinchillas are highly susceptible to leptospirosis compared to other laboratory rodents. Infection with *L. pomona* featured serous nasal discharge, anemia, icterus, and disseminated hemorrhages in all tissues, particularly in the lungs. In addition to hemorrhages, the liver and spleen were enlarged and congested, and fluid was present in the serosal cavities. Necrosis and inflammation were present in the liver, spleen, kidneys, and lungs, with adrenal medullary necrosis and hemorrhage. Argrophilic spirochetes can be present in large numbers within vascular lumina and various tissues.

Listeria monocytogenes

Listeriosis is caused by infection with *Listeria monocytogenes* or *L. ivanovii*, both of which have been documented in chinchillas. Animals of all ages are susceptible and generally present with chronic weight loss and eventual high mortality. *Listeria* bacteria can live extracellularly within the intestinal lumen, and cause diarrhea, but this is seldom reported. In contrast, the typical scenario is invasion of tissue with facultatively intracellular forms of the bacteria. They invade the intestinal mucosa, usually via the Peyer's patches, traffic to mesenteric lymph nodes and liver, and then the bloodstream, with dissemination to multiple organs. As facultative intracellular bacteria, they favor macrophages but infect other cell types, particularly hepatocytes. Listeriosis can manifest as a neurologic disease, reproductive tract disease, and/or septicemic disease. Neurologic infection is characterized by meningoencephalitis, typically involving the brain stem, and reproductive tract infection features metritis, fetal infection, and abortion.

Chinchillas have a propensity for septicemic listeriosis, although all three patterns may occur. Generally, milium to millet-sized pale foci are present on the intestine (Figure 6.8), liver (Figure 6.9), and spleen. These foci are granulomas with necrotic centers, consisting of macrophages and neutrophils (Figure 6.10), with Gram-positive bacteria within macrophages (Figure 6.11). There is also effacement of Peyer's patches and focal areas of the large intestinal wall with inflammation. Microabscesses in the brain stem may rarely be encountered, and reproductive tract infection with metritis and placentitis can also

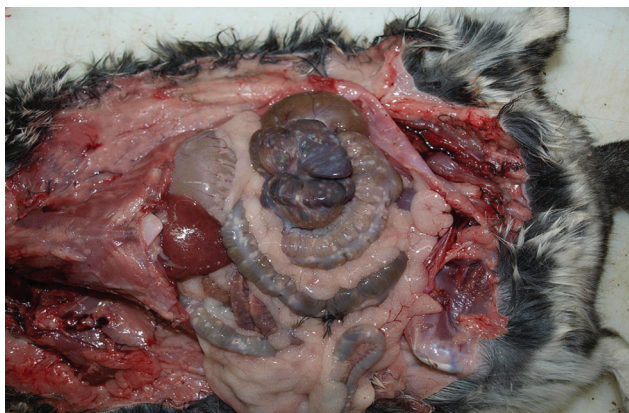


Figure 6.8 Listeriosis in a chinchilla. Note the multiple pale foci on the serosa of the small intestine, cecum, and colon. *Source:* The Joint Pathology Center (JPC)/United States Military/conference 3-2016, case: 1 20160907.

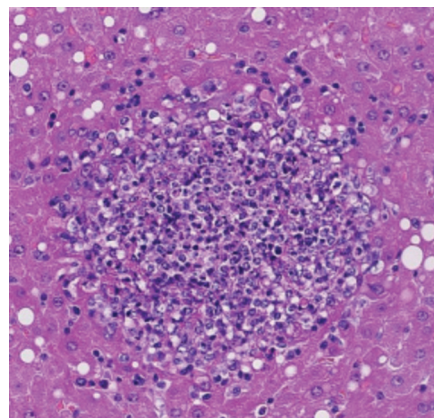


Figure 6.10 Listeriosis in a chinchilla. Focal hepatocellular necrosis with infiltration of degenerate neutrophils and a few macrophages. *Source:* The Joint Pathology Center (JPC)/United States Military/conference 3-2016, case: 1 20160907.

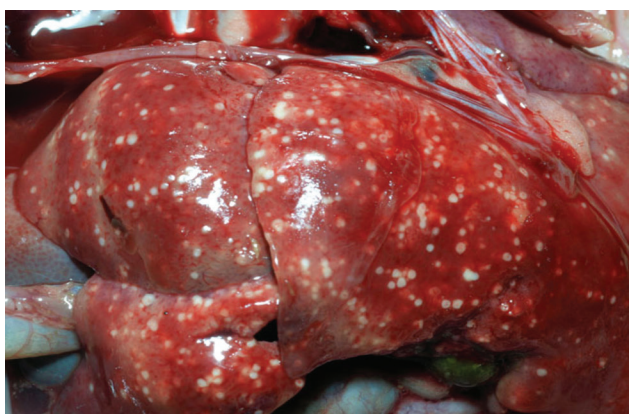


Figure 6.9 Listeriosis in a chinchilla. Note the numerous pale foci on the capsular surface of the liver, which are also throughout the parenchyma. *Source:* Joint Pathology Center, conference 08-2008, case 20081105. United States Military. Contributed by Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Zagreb, Croatia.

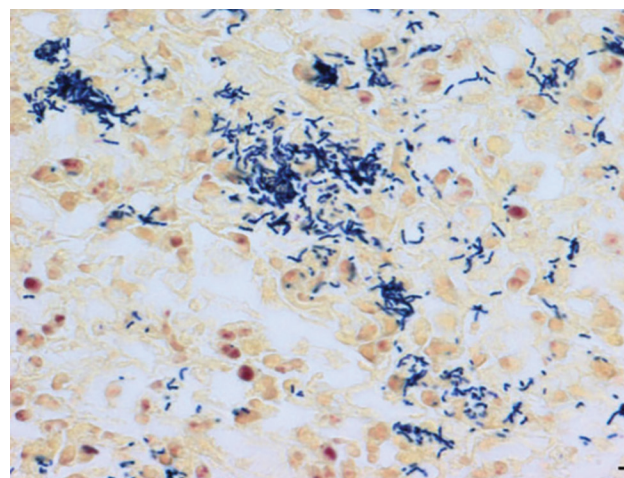


Figure 6.11 Listeriosis in a chinchilla. Brown and Brenn stain of the liver reveals numerous Gram-positive rod-shaped bacteria in foci of necrosis. *Source:* Joint Pathology Center, conference 08-2008, case 20081105. United States Military. Contributed by Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Zagreb, Croatia.

occur. Miliary granulomas may be visible on fetal livers. Differential diagnosis must include disseminated *Yersinia*, *Salmonella*, *Pseudomonas*, and *Mycobacterium*. Although Tyzzer's disease has not been reported in chinchillas, it should be considered as well.

***Mycobacterium* spp.**

There are single reports of pet chinchillas infected with *Mycobacterium genavense* and *M. avium* subsp. *hominissuis*. The animal infected with *M. genavense* had focal granulomas in the lung and liver, whereas the animal infected with *M. avium* had granulomas in the uterus, lung, mediastinal lymph node, mesenteric lymph node, intestine, pancreas, and kidneys. In both cases, numerous acid-fast bacteria were noted within the granulomata. Chinchillas

on a ranch in Canada presented with emaciation and eventual death due to *M. tuberculosis* infection. They acquired infection by exposure to an infected caretaker. Affected animals had randomly distributed caseous granulomas in various tissues.

Pasteurella multocida

Chinchillas, like rabbits, can suffer from acute and chronic infection with *Pasteurella multocida*. Chronic infections in adult chinchillas involve purulent rhinitis, conjunctivitis, and otitis. Acute disease typically involves younger animals, which may develop purulent nasal discharge,

dyspnea, suppurative bronchopneumonia, otitis media/interna, meningoencephalitis, and hemorrhagic septicemia with pulmonary and visceral hemorrhages. In addition, this bacterium is often found in abscesses resulting from fight wounds and in cases of metritis.

Proteus mirabilis (and *Enterobacter aerogenes*)

Various surveys of disease among farmed chinchillas list enteric disease due to *Proteus mirabilis*. One outbreak of disease in a chinchilla farm had approximately 30% mortality. The disease was associated with *P. mirabilis* and *Enterobacter aerogenes* septicemia. Affected animals displayed conjunctivitis, cough, severe dyspnea, diarrhea and/or constipation, rectal prolapse, and vulvovaginitis. Intestinal lesions consisted of mucoid enteritis and cecal tympany, mesenteric petechiae, and ecchymoses. Inflammatory lesions in the intestine were variable and often absent. The trachea, bronchi, and bronchioles contained hemorrhagic frothy fluid, with interstitial edema and mild leukocytic infiltration. Culture of intestine, lung, conjunctiva, vagina, and rectum revealed pure cultures of *P. mirabilis* and/or *E. aerogenes*. A low-fiber diet was suspected as an underlying factor, and modification of the diet with addition of alfalfa hay resulted in the improvement of the colony health. Other cases, generally sporadic, have involved enteritis, intussusception, pneumonia, and metritis.

Pseudomonas aeruginosa

Pseudomonas aeruginosa is a ubiquitous and significant opportunistic pathogen that can cause havoc in chinchillas in a plethora of ways. Unfortunately, infection is quite common in individual animals and in herds. Infection is acquired through water sources, as with other laboratory rodents. A common manifestation is rhinitis and conjunctivitis (Figure 6.12), with extension to the middle and inner ears through the eustachian tubes, resulting in purulent otitis media and interna. The characteristic pus is greenish in coloration. Corneal and oral ulcers may be present. Chinchillas with otitis can have facial paralysis and vestibular signs, including torticollis (Figure 6.13), ataxia, rolling, and circling. In addition to upper respiratory infection, this agent can cause suppurative bronchopneumonia, embolic pneumonia, and mild to severe enteritis with intestinal tympany. *Pseudomonas* septicemia can cause sudden death without clinical signs. At necropsy, numerous white foci (necrosis and inflammation) may be visible on the liver and intestinal serosa, as well as serous peritonitis and disseminated petechiae. More localized infections include wound abscessation, dermal pustules, metritis, abortion, and mastitis.



Figure 6.12 Purulent conjunctivitis in a chinchilla infected with *Pseudomonas aeruginosa*. Source: Reproduced with permission from Ozawa et al. (2017)/John Wiley & Sons.

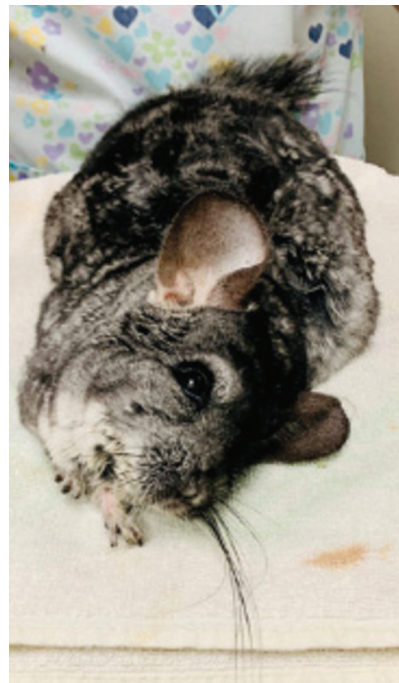


Figure 6.13 Torticollis in a chinchilla with otitis media/interna. Source: Reproduced with permission from Graham and Mans (2021)/John Wiley & Sons.

Salmonella enterica

A major cause of enteritis and septicemia in chinchillas is *Salmonella enterica*, including serovars Typhimurium, Arizonae, Enteritidis, Dublin, and Sophia. Infection has been the cause of multiple outbreaks in farmed chinchillas and in pet chinchillas. One report described affected animals to be anorectic and moribund, with abortions among pregnant animals. Necropsy revealed gastritis, enterocolitis, focal pneumonia with edema, acute necrotizing hepatitis,

splenitis, nephritis, and lymphadenitis. Multiple pinpoint white foci (focal necrosis and inflammation) were present in multiple organs, particularly the liver (Figure 6.14) and spleen (Figure 6.15). Mesenteric lymph nodes and Peyer's patches (Figure 6.16) were enlarged. The small intestine had a disruption of mucosa with necrosis and infiltration of neutrophils, coinciding with the demonstration of *Salmonella* bacteria in the tissue by immunohistochemistry. Cholecystitis and metritis can also be associated with *Salmonella* infection.

Staphylococcus aureus

Second to *P. aeruginosa*, *Staphylococcus aureus* is a common cause of conjunctivitis, as well as rhinitis and



Figure 6.14 Salmonellosis in a chinchilla. Note the multiple pinpoint foci on the capsular surface of the liver. *Source:* Reproduced with permission from Santos et al. (2022)/Elsevier.



Figure 6.15 Salmonellosis in a chinchilla. Note the multiple pinpoint foci on the serosal surface of the spleen. *Source:* Reproduced with permission from Santos et al. (2022)/Elsevier.

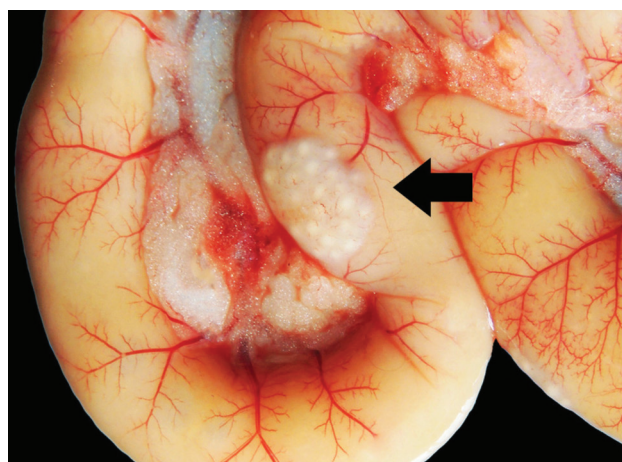


Figure 6.16 Salmonellosis in a chinchilla. Note the multiple pale foci within the Peyer's patch (arrow) of the intestine. *Source:* Reproduced with permission from Santos et al. (2022)/Elsevier.

otitis in chinchillas. It has also been implicated as a cause of pneumonia in chinchillas, but details have not been published. A rare entity is pseudomembranous enterocolitis, in which pure cultures of *S. aureus* are present. An outbreak was reported in a herd of chinchillas that were fed a diet containing tetracycline. The syndrome has been reproduced in chinchillas inoculated orally with *S. aureus* or administered the toxin. The lesions resemble Clostridial enterotoxemia. This syndrome has also been reported in humans. In addition to pneumonia and enteritis, *S. aureus* can be an opportunistic pathogen in pododermatitis (bumblefoot) and wound infections.

Streptococcus spp.

Various reports list infection with *Streptococcus* sp., including both hemolytic and nonhemolytic isolates, but the species have not been identified. Descriptions of chinchillas with pneumonia and pleuritis are suggestive of *S. pneumoniae* (diplococcus). Chinchillas are readily infected experimentally with diplococcus following intranasal inoculation and develop suppurative otitis media, particularly when coinfecting with influenza virus. This has served as an important model of otitis media pathogenesis and therapy.

Streptococcus equi subsp. *zooepidemicus*

Cervical lymphadenitis is relatively rare in chinchillas, but cases of abscessation of cervical and axillary lymph nodes (Figure 6.17) have been reported in pet and laboratory chinchillas. In addition, this organism has been associated with purulent conjunctivitis.

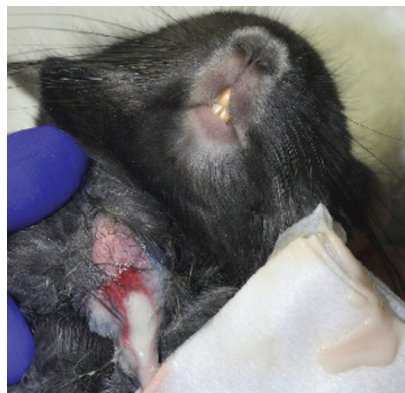


Figure 6.17 Cervical lymphadenitis with draining abscess in a chinchilla infected with *Streptococcus equi* subsp. *zooepidemicus*. Source: Reproduced with permission from Berg et al. (2019)/Elsevier.

Trueperella pyogenes

Previously named *Actinomyces pyogenes*, then *Corynebacterium pyogenes*, then *Arcanobacterium pyogenes*, the nomenclature has now settled on *Trueperella pyogenes*. This organism is largely an opportunistic bacterium and has been associated with single cases of metritis in chinchillas.

Yersinia enterocolitica and *Y. pseudotuberculosis*

Both *Yersinia* species have been known to infect farmed and pet chinchillas in North America, South America, and Europe, extending back into the early days to the present times of chinchilla domestication. *Yersinia enterocolitica* is a very heterogeneous species, with six biotypes (biovars) and many serotypes that can be roughly matched with pathogenicity, whereas *Y. pseudotuberculosis* is less heterogeneous and has 4 biotypes that cannot be matched with disease. Notably, chinchilla isolates of *Y. enterocolitica* in Europe were shown to have similar biotype/serotype profiles as chinchilla isolates in Canada and Europe from over 30 years previously, suggesting that a *Y. enterocolitica* chinchilla biotype has been endemic in domesticated chinchilla populations from the outset. Many infections are subclinical, but when there is disease, *Yersinia* bacteria tend to enter the gut wall of the terminal ileum through M cells of Peyer's patches, resulting in focal fibrinopurulent necrotizing enteritis. They then spread to mesenteric lymph nodes and other tissues. Gross findings include splenomegaly, hepatomegaly, and multifocal pale foci in the liver, spleen, lung, kidney, mesentery, and serosa. These foci consist of necrotizing lesions with neutrophils, macrophages, and fibrin surrounding central necrotic cores containing large colonies of Gram-positive coccobacillary bacteria.

Bibliography for Bacterial Infections

Campylobacter lanienae

Turowski, E.E., Shen, Z., Ducore, R.M., Parry, N.M.A., Kirega, A., Dewhirst, F.E., & Fox, J.G. (2014) Isolation of a *Campylobacter lanienae*-like bacterium from laboratory chinchillas (*Chinchilla laniger*). *Zoonoses Public Health* 61:571–580.

Clostridium perfringens

Bartoszcze, M., Nowakowska, M., Roszkowski, J., Matras, J., Palec, S., & Wystup, E. (1990) Chinchilla deaths due to *Clostridium perfringens* A enterotoxin. *Veterinary Record* 126:341–342.

Carpenter, J.W. & Harms, C.A. (2022) *Exotic Animal Formulary*, 6th edn. Elsevier, New York.

Lucena, R.B., Farias, L., Libardoni, F., Vargas, A.C., Giaretta, P.R., & Barros, C.S.L. (2011) Necrotizing enteritis associated with *Clostridium perfringens* type B in chinchillas (*Chinchilla lanigera*). *Pesquisa Veterinaria Brasileira* 31:1071–1074.

Lucena, R.B., Giaretta, P.R., Tessele, B., Figuera, R.A., Kommers, G.D., Irogoyen, L.F., & Barros, C.S.L. (2012) Diseases of chinchilla (*Chinchilla lanigera*). *Pesquisa Veterinaria Brasileira* 132:529–535.

Moore, R.W. & Greenlee, H.H. (1975) Enterotoxemia in chinchillas. *Laboratory Animals* 9:153–154.

Uzal, F.A., Vidal, J.E., McClane, B.A., & Gurjar, A.A. (2010) *Clostridium perfringens* toxins involved in mammalian veterinary diseases. *Open Toxinology Journal* 2:24–42.

Escherichia coli

Diaz, L.L., Lepherd, M., & Scott, J. (2013) Enteric infection and subsequent septicemia due to attaching and effacing *Escherichia coli* in a chinchilla. *Comparative Medicine* 63:503–507.

Klebsiella pneumoniae

Bartoszcze, M., Matras, J., Palec, S., Roszkowski, J., & Wystup, E. (1990) *Klebsiella pneumoniae* infection in chinchillas. *Veterinary Record* 127:119.

Leptospira interrogans

Roberts, C.S. & Turner, L.W. (1958) The susceptibility of the chinchilla (*Chinchilla laniger*) to *Leptospira Pomona*. *Journal of the American Veterinary Medical Association*. 132:527–528.

Turner, L.W. (1961) Experimental leptospirosis in the chinchilla (*Chinchilla laniger*). *Cornell Veterinarian* 51:420–430.

Listeria monocytogenes

Du Plessis, J.L. & Cameron, C.M. (1965) Listeriosis in chinchillas. *Journal of the South African Veterinary Medical Association* 36:107–111.

- Finley, G.G. & Long, J.R. (1977) An epizootic of listeriosis in chinchillas. *Canadian Veterinary Journal* 18:164–167.
- Kimpa, A., Docostere, A., Hermans, K., & Baele, M. (2004) Isolation of *Listeria invanovii* from a septicemic chinchilla (*Chinchilla lanigera*). *Veterinary Record* 154:791–792.
- Sabocanec, R., Culjak, K., Ramadan, K., Naglic, T., Seol, B., & Maticic, D. (2000) Incidence of listeriosis in farm chinchillas (*Chinchilla laniger*) in Croatia. *Veterinarski Arhiv* 70:159–167.
- Wilkerson, M.J., McLendy, A., & Stauber, E. (1997) An outbreak of listeriosis in a breeding colony of chinchillas. *Journal of Veterinary Diagnostic Investigation* 9:320–323.

Mycobacterium spp.

- Barthel, Y., Drews, S., Fehr, M., Moser, I., Matz-Rensing, K., Baumgartner, W., & Wohlsein, P. (2016) Concurrent infection with *Mycobacterium avium* subsp. hominissuis and *Giardia duodenalis* in a chinchilla (*Chinchilla lanigera* f. dom.). *Berliner und Munchener tierärztliche Wochenschrift* 129:242–246.
- Huynh, M., Pingret, J.-L., & Nicolier, A. (2014) Disseminated *Mycobacterium genavense* infection in a chinchilla (*Chinchilla lanigera*). *Journal of Comparative Pathology* 151:122–125.

Proteus mirabilis (and Enterobacter aerogenes)

- Bautista, E., Martino, P., Manacorda, A., Cossu, M.E., & Stanchi, N. (2007) Spontaneous *Proteus mirabilis* and *Enterobacter aerogenes* infection in chinchilla (*Chinchilla lanigera*). *Scientifur* 31:27–30.

Pseudomonas aeruginosa

- Doerning, B.J., Brammer, D.W., & Rush, H.G. (1993) *Pseudomonas aeruginosa* infection in a *Chinchilla lanigera*. *Laboratory Animals* 27:131–133.
- Graham, J.E. & Mans, C. (2021) Chinchillas. In: *Exotic Animal Emergency Critical Care and Medicine* (eds. J.E. Graham, G.A. Doss, & H. Beaufrière), Chapter 17. Wiley.
- Hirakawa, Y., Sasaki, H., Kawamoto, E., Ishikawa, H., Matsumoto, T., Aoyama, N., Kawasumi, K., & Amao, H. (2010) Prevalence and analysis of *Pseudomonas aeruginosa* in chinchillas. *BMC Veterinary Research* 6:52.
- Mans, C. & Donnelly, T.M. (2021) Chinchillas. In: *Ferrets, Rabbits, and Rodents*, 4th edn (eds. K.E. Quesenberry, C.J. Orcutt, C. Mans, & J.W. Carpenter), pp. 298–322. Elsevier.
- Stoica, C. *Pseudomonas aeruginosa* isolated from chinchilla. *Regnum Prokaryotae*. tgw1916.net/articles/pseudomonas_chinchilla.html.
- Wideman, W.L. (2006) *Pseudomonas aeruginosa* otitis media and interna in a chinchilla ranch. *Canadian Veterinary Journal* 47:799–800.

Salmonella enterica

- Naglic, T., Seol, B., Bedekovic, M., Grabarevic, Z., & Listes, E. (2003) Outbreak of *Salmonella enteritidis* and isolation

of *Salmonella Sophia* in chinchillas (*Chinchilla laniger*). *Veterinary Record* 152:719–720.

- Santos, I.R., Raiter, J., Dal Pont, T.P., Brunner, C.B., Lopes, B.C., Cecco, B.S., Mololsssi, F., Bandinelli, M.B., Panziera, W., Pavarini, S.P., & Driemeir, D. (2022) Pathology of *Salmonella enterica* subspecies *enterica* serotype Typhimurium infection in chinchillas (*Chinchilla lanigera*). *Journal of Comparative Pathology* 194:14–21.

Staphylococcus aureus

- Van Promaska, J. (1959) Pseudomembranous enterocolitis: the experimental induction of the disease with *Staphylococcus aureus* and its enterotoxin. *American Medical Association Archives of Surgery* 79:43–52.
- Wood, J.S., Bennett, I.V., & Yardley, J.H. (1956) Staphylococcal enteritis in chinchillas. *Bulletin of the Johns Hopkins Hospital* 98:454–463.

Streptococcus spp.

- Berg, C.C., Doss, G.A., & Mans, C. (2019) *Streptococcus equi* subspecies *zooepidemicus* infection in a pet chinchilla (*Chinchilla lanigera*). *Journal of Exotic Pet Medicine* 31:36–38.
- Giebink, G.S., Berzins, I.K., Marker, S.C., & Schiffman, G. (1980) Experimental otitis media after nasal inoculation of *Streptococcus pneumoniae* and influenza A virus in chinchillas. *Infection and Immunity* 30:445–450.
- Mitchell, C., Johnson, L.K., Crim, M.J., Wiedmeyer, C.E., Pugazhenth, U., Tousey, S., Tollin, D.J., Habenicht, L.M., Fink, M.K., Fong, D.L., Leszczynski, J.K., & Manuel, C.A. (2020) Diagnosis, surveillance and management of *Streptococcus equi* subspecies *zooepidemicus* infections in chinchillas (*Chinchilla lanigera*). *Comparative Medicine* 70:370–375.

Yersinia enterocolitica and Y.pseudotuberculosis

- Sonne, L., Raymundo, D.L., Boabaid, F.M., Borba, M.R., Snel, G.G.M., Gomes, M.J.P., & Driemeir, D. (2012) Infecção sistêmica por *Yersinia enterocolitica* em chinchillas (*Chinchilla laniger*). *Pesquisa Veterinária Brasileira* 32:379–382.
- Strandtmann, R.W. (1948) *Atricholaelaps traubi* and *A. chinchillulae*, from *Callosciurus* and the chinchilla respectively. *Proceedings of the Entomological Society of Washington* 50:187–192.
- Wuthe, H.-H. & Aleksic, S. (1992) *Yersinia enterocolitica* serovar 1,2a,3 biovar 3 in chinchillas. *Zentralblatt Bakteriologie* 277:403–405.

Fungal Infections

Dermatophytosis

Ringworm is most commonly due to *Trichophyton mentagrophytes* in chinchillas, but *Microsporum canis* and



Figure 6.18 Dermatomycosis involving the muzzle of a chinchilla infected with *Microsporum canis*. Source: Marietto-Goncalves (2015)/Guilherme Augusto Marietto Goncalves.

M. gypseum have also been implicated. Lesions consist of focal areas of alopecia and scaling, crust formation, and erythema, usually around the nose (Figure 6.18), eyes, ears, feet, flank, and tail.

Cryptococcus sp.

A single case of cryptococcal meningitis and optic neuritis in a chinchilla has been reported. The species was not identified.

Histoplasma capsulatum

Histoplasmosis was noted in a single chinchilla from a Missouri chinchilla farm that experienced multiple deaths due to other causes. *Histoplasma* organisms were found within focal granulomas in the lungs, liver, spleen, kidneys, and lymph nodes of the single animal. The fungus was cultured from timothy hay that was fed to the animals.

Pneumocystis sp.

Pneumocystis species are a heterogeneous group of extracellular fungi that have a high degree of host specificity (stenoxenic), infecting virtually every type of mammal. Their niche is within pulmonary alveoli, with trophic forms attaching to type I alveolar cells and the development of argyrophilic spores within alveolar lumina. Confusing terminology, such as the use of the terms “trophozoites” and “cysts” (as well as “-cystis” within the name itself), are relics of earlier classification as protozoa. Each species

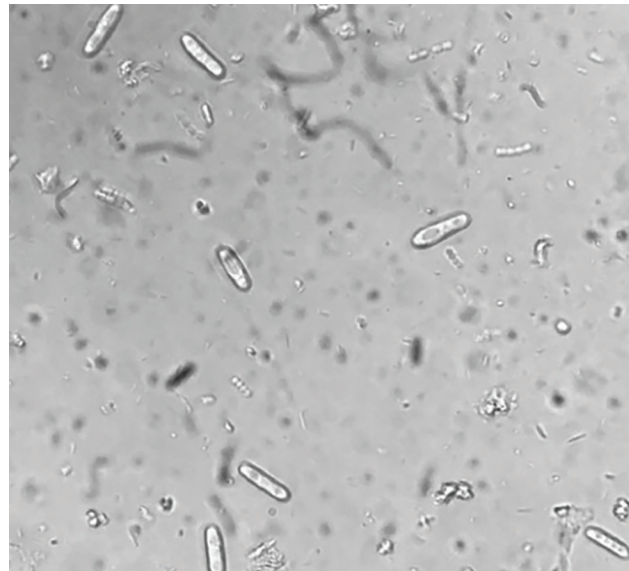


Figure 6.19 Fecal cytology from a chinchilla with diarrhea, depicting the large, elongated *Cyniclomyces guttulatus* overgrowth. Source: Reproduced with permission from Graham and Mans (2021)/John Wiley & Sons.

co-evolved in parallel with the phylogeny of its mammalian host. Several species have been officially named and characterized (*P. jiroveci* in humans, *P. murina* in mice, *P. carinii* and *P. wakefieldae* in rats, and *P. oryctolagi* in rabbits), but each of these is unique to their individual hosts (i.e., no interspecies infection). Although *Pneumocystis* fungi have been documented in chinchillas (and virtually every other mammal tested), no lesions have been reported. These mildly pathogenic organisms only produce lesions in immunosuppressed hosts.

Commensal or Opportunistic Yeasts

Large numbers of the yeast, *Cyniclomyces guttulatus* (formerly *Saccharomyces guttulatus*), can be found adjacent to the stomach mucosa in normal chinchillas, as well as in chinchillas with enteritis, but they have not been proven to be pathogenic. Overgrowth of the yeast may occur with underlying dysbiosis, with large numbers of the yeast apparent in feces (Figure 6.19). These yeast forms resemble very large bacteria. Otitis externa has been attributed to *Malassezia pachydermatis* in chinchillas, but this has not been confirmed in peer-reviewed publications.

Bibliography for Fungal Infections

Donnelly, T.M., Rush, E.M., & Lackner, P.A. (2000) Ringworm in small exotic pets. *Seminars in Avian and Exotic Pet Medicine* 9:82–93.

- Graham, J.E. & Mans, C. (2021) Chinchillas. In: *Exotic Animal Emergency Critical Care and Medicine* (eds. J.E. Graham, G.A. Doss, & H. Beaufrère), Chapter 17, pp. 310–329. Wiley.
- Marietto-Goncalves, G.A. (2015) Ringworm by *Microsporum canis* in long-tailed chinchilla (*Chinchilla lanigera*). *Acta Veterinaria Brasilica* 9:274–278.
- Morganti, L. & Gomez Portugal, E.A. (1970) *Microsporum gypseum* infection in chinchillas. *Sabouraudia* 8:39–40.icro.
- Owens, D.R., Menges, R.W., Sprouse, R.F., Stewart, W., & Hooper, B.E. (1975) Naturally occurring histoplasmosis in the chinchilla (*Chinchilla laniger*). *Journal of Clinical Microbiology* 1:486–488.
- Weissenbacher-Lang, C., Blasi, B., Bauer, P., Binanti, D., Bitterman, K., Ergin, L., Hogler, C., Hogler, T., Klier, M., Matt, J., Nedorost, N., Silvestri, S., Stixenberger, D., Ma, L., Cisse, O.H., Kovacs, J.A., Desvars-Larrive, A., Posautz, A., & Weissenbock, H. (2023) Detection of *Pneumocystis* and morphological description of fungal distribution and severity of infection in thirty-six mammal species. *Journal of Fungi (Basel)* 9:220.
- Zierdt, C.H., Detlefson, C., Muller, J., & Waggle, K.S. (1988) *Cyniclomyces guttulatus* (*Saccharomycopsis guttulata*)—culture, ultrastructure and physiology. *Antonie van Leeuwenhoek* 54:357–366.

Parasite Infections

Protozoal Infections

Cryptosporidium spp.

Cryptosporidium ubiquitum is an important emerging zoonotic pathogen in humans that infects a broad spectrum of animals, including humans. This species is divided into four genotypes (XIIa–XIIId), based upon sequence of the *gp60* gene. Humans can develop diarrhea when infected with any of the four genotypes. Asymptomatic pet chinchillas in China were found to be infected with XIIa and XIIId genotypes, based upon PCR/sequencing analysis. In addition, *C. parvum* and a chipmunk genotype V *cryptosporidium* have been detected by PCR/sequencing in chinchillas in China. Among juvenile chinchillas imported from the Czech Republic to Japan, *C. ubiquitum* type XIIId was documented. Some of the infected animals died or were moribund with diarrhea, and one had rectal prolapse and intestinal intussusception. Histopathology revealed cryptosporidia attached to the brush border of jejunal and ileal epithelium (Figure 6.20).

Eimeria chinchillae

A single enteric coccidium, *Eimeria chinchillae*, infects chinchillas. There is very little information on this species. It apparently replicates in the cecum. It has been noted to cause serious losses in farmed chinchillas and is of sufficient concern to warrant the inclusion of coccidiostats

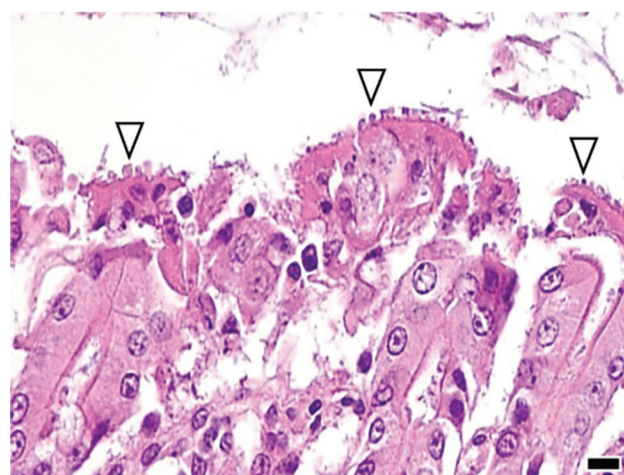


Figure 6.20 Cryptosporidiosis in a chinchilla. Note the organisms attached within the apical cytoplasm of surface enterocytes (arrowheads). *Source:* Reproduced with permission from Kubota et al. (2029)/Elsevier.

in the feed of farmed chinchillas. Experimental studies have shown that *E. chinchillae* can infect several other rodent hosts.

Frenkelia microti

Single cases of *Frenkelia microti* (presumptive species) cysts in the brains of a pet and a farmed chinchilla are reported. DNA analysis of *Frenkelia* indicate close relationship to *Sarcocystis*, and it has been suggested to change the genus name to *Sarcocystis*. Chinchillas become infected through contamination of feed with feces from birds of prey. After ingestion, cysts invade the intestinal wall, migrate to the liver, undergo schizogony in hepatocytes and Kupffer cells, then disseminate to the brain, forming characteristic multilobulated cysts containing numerous bradyzoites.

Giardia duodenalis

In various surveys, a majority (~60%) of chinchillas from Europe and South America have been found to carry *Giardia duodenalis*. Genetic analysis of *G. duodenalis* isolates from several different hosts indicate that there are eight different assemblages (A–H). Assemblages A and B are those that infect humans. Assemblages A, B, C, D, and E have all been detected in fecal samples of chinchillas by PCR/sequencing analysis. Most infections are subclinical, and when disease (diarrhea) is present, there are often other factors involved. Diagnosis is by fecal examination for cysts and visualization of typical extracellular trophozoites aligned along villi.

Sarcocystis spp.

Infections with *Sarcocystis* spp. are rare in chinchillas. There is a single case report of *S. canis* infection in the liver

of a pet chinchilla. There were numerous, often coalescing, randomly distributed foci of hepatic necrosis with infiltration of neutrophils and macrophages. Multiple stages of schizonts and merozoites were present. This species of *Sarcocystis* has an unusual life cycle involving the liver and is associated with hepatitis in other host species (dogs and bears). *S. muris* has also been documented in chinchillas.

Toxoplasma gondii

Outbreaks of disseminated toxoplasmosis have been described in farmed chinchillas. Animals can present with mucopurulent ocular and nasal discharge, diarrhea, and high mortality. In acute cases, lungs are white to grey and edematous, but later have pinpoint white foci, with clear straw-colored pleural exudate, and to a lesser degree, peritoneal exudate. Livers have multiple white pinpoint foci. Spleens and mesenteric lymph nodes are enlarged. Microscopic lesions consist of pulmonary interstitial inflammation, septal thickening, edema, and increased alveolar macrophages. There are multifocal areas of necrosis and inflammation in liver and heart, and lymphoid hyperplasia in the spleen. Multifocal granulomatous encephalitis with gliosis, and lymphoplasmacytic meningitis are often present. Lesions all contain bradyzoites and pseudocysts filled with tachyzoites. A dual infection of *T. gondii* and *F. microti* has been reported.

Commensal Protozoa

Amoebae and *Balantidium coli* are nonpathogenic commensal protozoa of chinchillas.

Helminth Infestations

Baylisascaris procyonis

Multiple cases of larval migrans due to the racoon ascarid, *Baylisascaris procyonis*, have been reported in chinchillas, including 100 affected animals among 3 farms in Canada that shared animals, equipment, and feed. The farms stored hay in a common barn that was infested with a family of racoons. Affected chinchillas had ataxia, torticollis, incoordination and tumbling. Foci and tracks of malacia with varying degrees of leukocytic infiltration, consisting of macrophages, eosinophils, and lymphocytes, were present in the midbrain, medulla and cerebellar peduncles. Meninges had focal infiltrates of mixed leukocytes.

Miscellaneous Nematodes

Intestinal nematodiasis is rare in chinchillas. Chinchillas have been found to be infested with *Haemonchus contortus*, *Ostertagia ostertagi*, *Physaloptera* sp., *Trichostrongylus colubriformis*, *Trichuris* sp., and an unspicated oxyurid. There is an anecdotal report of *Syphacia obvelata* as an uncommon

finding in chinchillas. These have been incidental findings, although one case of mortality occurred in a chinchilla infected with *H. contortus*.

Rodentolepis nana

Chinchillas can have a curiously high rate of infestation with *Rodentolepis nana* in certain regions. A survey of pet chinchillas in Italy noted a 25% rate of infestation. Adult forms of this tapeworm are small and inhabit the small intestinal lumen, and cysticercoids can be observed in the lamina propria, submucosa, liver parenchyma, and portal veins. These features underscore the direct life cycle of this tapeworm that does not require an intermediate host, allowing superinfection in individuals.

Tapeworm Cysts

Chinchillas can serve as intermediate hosts for *Taenia crassiceps*, *T. multiceps*, *T. pisiformis*, *T. serialis*, and *T. taeniaformis*. Excepting *T. pisiformis* and *T. taeniaformis*, the cysts of these tapeworms are coenuri, containing multiple protoscolices. Cysts of *T. pisiformis* and *T. taeniaformis* are cysticerci, in which only a single inverted protoscolex exists. Following ingestion of eggs of these tapeworm species in the environment, oncospheres hatch and invade the intestinal wall, then disseminate to various tissues. Coenuri can form in multiple sites, but those of *T. serialis* tend to occupy the muscle and subcutis, whereas others are often found in the peritoneal cavity (Figure 6.21). *Taenia pisiformis* and *T. taeniaformis* cysticerci are commonly found in the liver and peritoneum and mature into infectious strobilocerci. Hydatid cysts (containing cysticercoid larvae) have also been found in chinchillas. They are due to infestation with *Echinococcus granulosus* or *E. multilocularis*. The definitive hosts for these tapeworms are various carnivores,

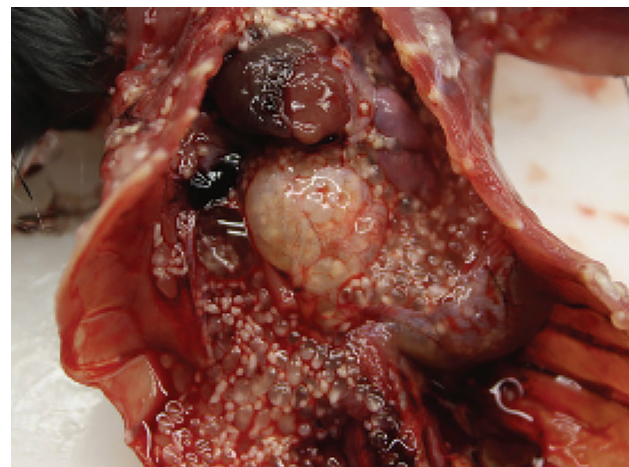


Figure 6.21 Generalized cysticercosis (*Taenia crassiceps*) in a chinchilla from an animal shelter in Europe. Source: Reproduced with permission from Basso et al. (2014)/Elsevier.

and infestation of chinchillas is through contamination of their feed with feces from these hosts.

Trematodes

Numerous immature or intermediate forms of an unidentified trematode were noted in the liver of chinchillas that fed upon marsh grass on a farm.

Arthropod Infestations

The extremely dense fur of the chinchilla and their use of dust baths tend to preclude ectoparasitism.

Atricholaelaps chinchillulae

Very little is known about this hematophagous mesostigmate mite that was described in 1948. Infestation with a “red” mite causing pruritic dermatitis in farmed chinchillas (and their handlers) in Canada may be due to this mite, or possibly an *Ornithonyssus* sp.

Other Arthropods

Infestation with *Cheyletiella parasitovorax* and ear mites (*Psoroptes*?) are described anecdotally, as are infestations with dog and cat fleas. A survey of chinchillas in Brazil reported infestation with unidentified lice in 3 and fleas in 4 chinchillas among 202 necropsy cases. The lice were likely *Lagidiophthirus* sp., which infest members of Chinchillidae. Outdoor-raised animals are subject to fly strike (myiasis), including *Cuterebra*.

Bibliography for Parasite Infections

Protozoal Infections

Cryptosporidium spp.

- Chen, J., Wang, W., Lin, Y., Sun, L., Li, N., Guo, Y., Kvac, M., Ryan, U., Feng, Y., & Xiao, L. (2021) Genetic characterization of *Cryptosporidium* spp. from pet rodents indicate high zoonotic potential of pathogens from chinchillas. *One Health* 13:100269.
- Kubota, R., Matsubara, K., Tamukai, K., Ike, K., & Tokiwa, T. (2019) Molecular and histopathological features of *Cryptosporidium ubiquitum* infection in imported chinchillas *Chinchilla lanigera* in Japan. *Parasitology International* 68:9–3.
- Qi, M., Luo, N., Wang, H., Yu, F., Wang, R., Huang, J., & Zhang, L. (2015) Zoonotic *Cryptosporidium* spp. and *Enterocytozoon bieneusi* in pet chinchillas (*Chinchilla lanigera*) in China. *Parasitology International* 64:339–341.

Eimeria chinchillae

De Vos, A.J. (1970) Studies on the host range of *Eimeria chinchillae* de Vos and Van Der Westhuizen, 1968. *Onderstepoort Journal of Veterinary Research* 37:29–36.

Frenkelia microti, *Sarcocystis* spp., and *Toxoplasma gondii*

- Dubey, J.P., Clark, T.R., & Yantis, D. (2000) *Frenkelia microti* infection in a chinchilla (*Chinchilla laniger*) in the United States. *Journal of Parasitology* 86:1149–1150.
- du Plessis, J.L., Bigalke, R.D., & Gurnell, T.O. (1967) An outbreak of toxoplasmosis in chinchillas in South Africa. *Journal of the South African Veterinary Medical Association* 38:79–83.
- McAllister, R.A. (1964) An outbreak of toxoplasmosis in an Ontario chinchilla herd. *Canadian Journal of Comparative Medical Veterinary Science* 28:53–56.
- Meingassner, J.G. & Burtcher, H. (1977) Double infection of the brain with *Frenkelia* species and *Toxoplasma gondii* in *Chinchilla laniger*. *Veterinary Pathology* 14:146–153.
- Rakich, P.M., Dubey, J.P., & Contarino, J.K. (1992) Acute hepatic sarcocystosis in a chinchilla. *Journal of Veterinary Diagnostic Investigation* 4:484–486.

Giardia duodenalis

- Gherman, C.M., Kalmar, Z., Gyorke, A., & Mircean, V. (2018) Occurrence of *Giardia duodenalis* assemblages in farmed long-tailed chinchillas *Chinchilla lanigera* (Rodentia) from Romania. *Parasites and Vectors* 11:86.
- Jones, K.R. & Garcia, G.W. (2019) Endoparasites of domesticated animals that originated in the neo-tropics (New World Tropics). *Veterinary Sciences* 6:24–40.
- Levecke, B., Meulemans, L., Dalemans, T., Casaert, S., Claerebout, E., & Geurden, T. (2011) Mixed *Giardia duodenalis* assemblage A, B, C and E infections in pet chinchillas (*Chinchilla lanigera*) in Flanders (Belgium). *Veterinary Parasitology* 177:166–170.
- Panchev, N., Broglia, A., Paoletti, B., Vrhovec, M.G., Bertram, A., Nockler, K., & Caccio, S.M. (2014) Occurrence and molecular typing of *Giardia* isolates in pet rabbits, chinchillas, guinea pigs and ferrets collected in Europe during 2006–2012. *Veterinary Record* vr.102236.
- Soares, R.M., de Souza, S.L.P., Silveira, L.H., Funada, M.R., Richtzenhain, L.J., & Gennari, S.M. (2011) Genotyping of potentially zoonotic *Giardia duodenalis* from exotic and wild animals kept in captivity in Brazil. *Veterinary Parasitology* 180:344–348.

Helminth Infestations

- Basso, W., Rutten, M., Deplazes, P., & Grimm, F. (2014) Generalized *Taenia crassiceps* cysticercosis in a chinchilla (*Chinchilla lanigera*). *Veterinary Parasitology* 199:116–120.
- Cardia, D.F.F., Camossi, L.G., Hoppe, E.G.L., & Bresciani, K.D.S. (2016) An oxyurid nematode identified in a pet chinchilla (*Chinchilla lanigera*). *Journal of Exotic Pet Medicine* 25:311–313.
- d'Ovidio, D., Noviello, E., Pepe, P., Del Prete, L., Cringoli, G., & Rinaldi, L. (2015) Survey of *Hymenolepis* spp. in pet rodents in Italy. *Parasitology Research* 114:4381–4384.
- du Plessis, J.L. & Collins, M. (1968) A hymenolepid cysticercoid from the liver of chinchilla. *Journal of the South Africa Veterinary Medical Association* 39:69–72.

- Holmberg, B.J., Hollingsworth, S.R., Osofsky, A., & Tell, L.A. (2007) *Taenia coenurus* in the orbit of a chinchilla. *Veterinary Ophthalmology* 10:53–59.
- Kraft, H. (1960) *Haemonchus contortus* as the cause of death in a chinchilla. *Kleintier-Praxis* 5:61.
- Sanford, S.E. (1991) Cerebrospinal nematodiasis caused by *Baylisascaris procyonis* in chinchillas. *Journal of Veterinary Diagnostic Investigation* 3:77–79.
- Staebler, S., Steinmetz, H., Keller, S., & Deplazes. (2007) First description of natural *Echinococcus multilocularis* infections in chinchilla (*Chinchilla laniger*) and Prevost's squirrel (*Callosciurus prevostii borneoensis*). *Parasitology Research* 101:1725–1727.
- Stampa, S. & Hobson, N.K. (1966) Control of some internal parasites of chinchillas. *Journal of the American Veterinary Medical Association* 149:929–932.

Nutritional, Metabolic, and Toxic Disorders

Endocrinopathies

Diabetes is reportedly rare in chinchillas but is probably underdiagnosed. A few cases have been documented, but there is indirect evidence of underlying diabetes in older chinchillas with ocular cataracts and hyperglycemia. Hyperthyroidism was shown to occur in a chinchilla with diabetes mellitus. Hyperadrenocorticism and hyperthyroidism have both been demonstrated in fur-chewing chinchillas. Cushing's syndrome-like lesions have been shown to occur in the skin of fur-chewing chinchillas (see Fur-Chewing, below). Approximately one-third of chinchillas have been found to have adrenal cortical hyperplasia as an incidental finding. Much work is needed to thoroughly characterize endocrinopathies in chinchillas.

Vitamin Deficiency

Various forms of vitamin deficiency in chinchillas have been speculated upon, but none have been critically examined in the peer-reviewed literature.

Ketosis

Anorexia due to dental disorders, pain, gastrointestinal, and other illnesses readily predispose chinchillas to the development of ketosis. Gross findings reveal hepatic lipidosis (see Hepatic Lipidosis, below).

Heat Stress

Chinchillas are adapted to their native environment of high-altitude South America and, therefore, do poorly in

warm and humid environments. Their dense fur predisposes them to heat exhaustion and heat stroke.

Yellow Ear

Yellowish discoloration of ears, skin, and body fat is a syndrome due to excess plant pigments in the tissues. It can be reversed with choline, methionine, or vitamin E treatment. It is accompanied by hepatic lipidosis and thought to be due to decreased breakdown of carotene and other plant pigments.

Toxic Disorders

Chinchillas are highly sensitive to mycotoxins. Multiple cases of aflatoxicosis in farmed chinchillas feature high mortality and morbidity, with the primary lesion being hepatic lipidosis. Low levels of mycotoxins in feed cause less mortality, but liver lesions are often present.

Erroneous feed manufacturing, in which sodium carbonate was used instead of sodium bicarbonate, resulted in high mortality among farmed chinchillas. Over time, chinchillas developed extreme hair loss due to follicular atrophy and fur chewing, abortion, vaginal hemorrhage, whitish discoloration of teeth, mucoid diarrhea, and polyuria. Necropsy revealed peritoneal and pleural effusion, gastric ulcers, mesenteric hyperemia, empty intestinal tracts with enteritis, hepatic lipidosis and necrosis, and pulmonary edema. Contamination of feed with the organophosphate dieldrin resulted in hepatic lipidosis, gastric ulcers, and hemorrhagic kidneys. Oxylate nephrosis has been described in multiple chinchillas, with deposition of calcium oxylate crystalline material within renal convoluted tubules and tubular epithelial degeneration. Lead poisoning is an ever-present threat to pet chinchillas that chew on painted or soldered surfaces containing lead. Feed formulation of farmed chinchillas often contains ionophores, including narasin or salinomycin as coccidiostats. Excess amounts of these compounds have been implicated in chinchilla mortality due to myocardial and renal tubular necrosis.

Bibliography for Nutritional, Metabolic, and Toxic Disorders

Endocrinopathies

- Crossley, D.A. (2001) Dental disease in chinchillas in the UK. *Journal of Small Animal Practice* 42:12–19.
- Fritsche, R., Simova-Curd, S., Clauss, M., & Hatt, J.-M. (2008) Hyperthyroidism in connection with suspected diabetes mellitus in a chinchilla (*Chinchilla laniger*). *Veterinary Record* 163:454–456.

Marlow, C. (1995) Diabetes in a chinchilla. *Veterinary Record* 123:595–596.

Toxic Disorders

- Gonzalez Pereyra, M.L., Carvallo, E.C.Q., Tissera, J.L., Kellera, K.M., Magnoli, C.E., Rosa, C.A.R., Dalcera, A.M., & Cavaglieri, L.R. (2008) An outbreak of acute aflatoxicosis on a chinchilla (*Chinchilla lanigera*) farm in Argentina. *Journal of Veterinary Diagnostic Investigation* 20:853–856.
- Goudas, P. & Lusi, P. (1970) Oxylate nephrosis in chinchilla (*Chinchilla laniger*). *Canadian Veterinary Journal* 11:256–257.
- Land, M.F., Gonzalez Pereyra, M.L., Pena, G., Bagnis, G., Cavaglieri, L.R., Rosa, C.A.R., & Dalcero, A.M. (2012) Chronic exposure to aflatoxigenic fungi related to liver damage in pelt chinchillas (*Chinchilla lanigera*). *Revista Brasileira de Medicina Veterinaria* 34:303–310.
- Morgan, R.V., Moore, F.M., Pearce, L.K., & Rossi, T. (1991) Clinical and laboratory findings in small companion animals with lead poisoning: 347 cases (1977–1986). *Journal of the American Veterinary Medical Association* 199:93–97.
- Wojtacka, J., Szarek, J., Babinska, I., Felsmann, M., Strzyzewska, E., Szarek-Beska, A., Dublan, K., & Micinski, J. (2014) Sodium carbonate intoxication on a chinchilla (*Chinchilla lanigera*) farm: a case report. *Veterinarni Medicina* 59:112–116.

Non-neoplastic Organ System Disorders

Behavioral Disorders

Fur-Chewing

A major problem with chinchillas is fur-chewing, which occurs in 20%–30% of farmed chinchillas as well as pets and research chinchillas (Figure 6.22). It is hypothesized to

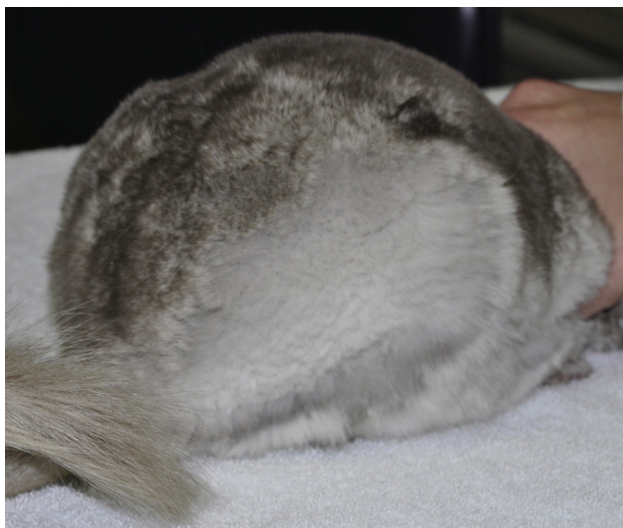


Figure 6.22 Fur chewing in a chinchilla. Source: Reproduced with permission from Martel et al. (2020)/Elsevier.

be a stress response. It has been shown that urinary cortisol levels and anxiety-related behaviors occurred in animals with the greatest degree of fur-chewing. Histopathology of the skin of fur-chewing chinchillas has revealed Cushing's syndrome-like changes, including epidermal atrophy, follicular and sebaceous atrophy, hyperkeratinization of follicles, comedo formation, and deposition of calcium salts in the subcutis. In addition to high cortisol levels, affected animals have also been shown to have hyperthyroidism. Fur-chewing is exacerbated by overcrowding, adverse management, and environmental factors. Fur-chewing animals have normal reproductive outcomes, but pup survival is lower with fur-chewing females. As with other rodents and rabbits, socially interactive barbering behavior also occurs among chinchillas, including whisker chewing and fur-chewing.

Trauma

Chinchillas live in large herds in their natural environment, and their social interactions are complex. Conditions of captivity can exacerbate fighting behavior. Females are the dominant sex and are more territorial compared to males. Females may be aggressive to one another and to males when in estrus. Males will fight among one another, but this can be minimized when they are co-housed before weaning. Fighting is usually inconsequential unless the combatants are unable to seek shelter. Outcomes include bite wounds, ear trauma, fur slip, and rarely death. Cutaneous abscesses may result, usually due to *P. multocida*, *S. aureus*, and *P. aeruginosa*. Chinchilla long bones are thin and fragile. Transverse and short spiral tibial fractures may occur due to inadequate housing environment or improper restraint.

Nervous System and Special Senses Disorders

Seizures

Chinchillas are prone to periodic seizures of generally unknown cause. They may arise following mating, possibly due to circulatory causes, and are known to occur in groups during feeding due to stress of others getting to the food first.

Automutilation

Mutilation of digits and limbs have been noted due to nerve trauma following intramuscular injections.

Ophthalmic Disorders

A common eye disorder in older chinchillas is epiphora, due to tooth root elongation impinging upon the lacrimal duct. Inflammation of the conjunctiva is also common. In addition to irritation caused by dust, foreign material,

and environmental ammonia, several bacteria can be associated with conjunctivitis, particularly *P. aeruginosa* and *S. aureus*, but also *B. bronchiseptica*, *P. multocida*, *P. mirabilis*, *Salmonella* spp., and *S. equi* subsp. *zooepidemicus*, among others. Conjunctivitis is often secondary to other systemic diseases. Conjunctivitis has been described in *Toxoplasma* infections, and localization of subconjunctival coenurus cysts has been reported.

Keratitis can be caused by several factors, including reduced palpebral reflex, which can result from facial nerve damage secondary to otitis media and interna. Herpesvirus simplex infection has been associated with keratoconjunctivitis. Anecdotal reports have attributed corneal xerosis to vitamin A deficiency. Cataracts are common in aged chinchillas and may be associated with underlying diabetes, since some cases have been shown to have high blood glucose levels.

Otitis Media/Interna

The very large tympanic bullae of chinchillas have favored their use in otitis research. Otitis media can be readily induced experimentally by direct or nasal inoculation with *S. pneumoniae*, enhanced by co-infection with influenza virus. Naturally occurring otitis is common. Affected animals may display torticollis when inflammation extends to the inner ear. Facial nerve damage may arise secondary to otitis media/interna, with reduced palpebral reflex resulting in keratoconjunctivitis. The most common causes of otitis are *P. aeruginosa*, *S. enterica*, *P. multocida*, and *B. bronchiseptica*, among others.

Digestive System Disorders

Oral and Dental Disease

It has been reported that approximately one-third of clinically normal pet chinchillas have some form of dental disease. Clinically affected animals may present with “slobbers” (ptyalism), anorexia, weight loss, constipation, or other manifestations. Diseases of oral soft tissue include cheilitis, gingivitis, buccal erosions, periodontal disease, gingival hyperplasia, and gingival pockets, which in turn can accumulate ingesta debris. Chinchillas are prone to the development of caries and tooth resorption. The elodont nature of both incisor and cheek teeth gives rise to malocclusion with tooth crown elongation (Figure 6.23). The normal anisognathism of chinchilla cheek teeth, coupled with occlusive wear, can result in coronal spikes, particularly among maxillary teeth (Figure 6.24). These can result in buccal erosions. Tooth root elongation is also common, which results in bony callus formation at the base of the roots. This can be especially discernable along the mandibular ramus (Figure 6.25). The long lifespan of

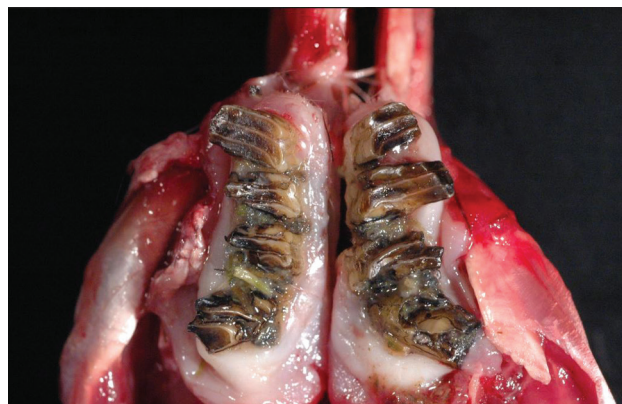


Figure 6.23 Mandible of a chinchilla with crown elongation of cheek teeth. *Source:* Elise LaDouceur, Veterinary Medical Teaching Hospital, University of California, Davis.

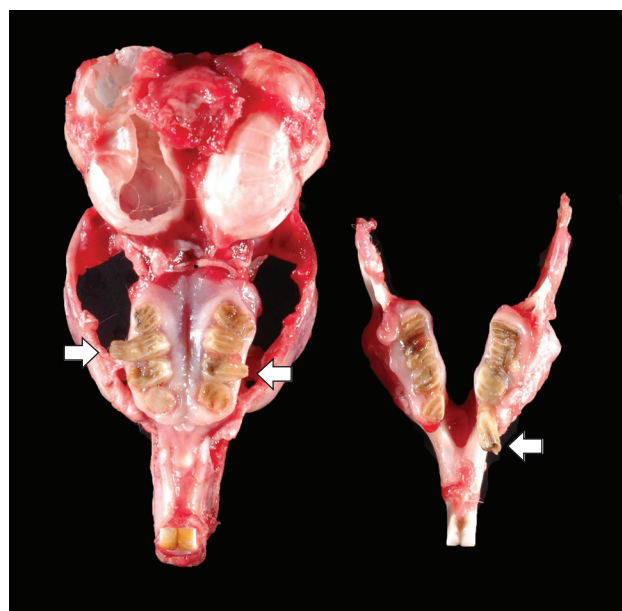


Figure 6.24 Dental spurs (arrows) arising on the buccal aspects of upper and lower cheek teeth in a chinchilla. *Source:* Dayna Goldsmith, Veterinary Medical Teaching Hospital, University of California, Davis.

pet chinchillas has resulted in an increase in issues related to tooth crown and root elongation. A common cause of epiphora is the impingement of the lacrimal canal by tooth root elongation. Excellent reviews are cited in the reference list for further information.

Odontogenic Dysplasia

Various terms have been proposed for odontogenic growths that arise from the apical bud of the elodont teeth of rodents and rabbits. Older chinchillas are prone to this condition due to their exceptional longevity compared to



Figure 6.25 Skull of a chinchilla with tooth crown and root elongation. Note the elongated cheek teeth and the nodular bony protuberances in the mandible and maxilla. There is also malocclusion of the incisors. *Source:* Derbaudrenghien et al. (2010)/Ghent University/Licensed under Creative Commons License CC BY-4.0.



Figure 6.26 Rectal prolapse in a chinchilla with concomitant intussusception. *Source:* Reproduced with permission from Graham et al. (2021)/John Wiley & Sons.

other rodents and rabbits. Odontogenic dysplasia is the best term to describe the common proliferative masses that arise from the tooth buds of incisors (usually maxillary) of aging rodents and rabbits. They arise in response to chronic trauma and inflammation. They consist of disorganized dysplastic proliferation of odontogenic components, including odontogenic epithelium, enamel matrix, dentin, cementum, and dental pulp. As they expand, they can impinge upon incisive bones, hard palate, and nasal cavities.

Gastric Ulcers

Gastric ulcers are common in young chinchillas and appear secondary to other systemic diseases. It has been speculated that they may be associated with a feeding course or moldy feed.

Intestinal Motility Disorders

Normal digestion is facilitated by the constant ingestion of fiber. When chinchillas become anorectic for a variety of reasons, they are prone to intestinal stasis (ileus), leading to tympany (bloat) or constipation. Lactating females are prone to intestinal tympany, often arising around 2–3 weeks after parturition. It has been speculated that it may be caused by hypocalcemia. Rarely, foreign bodies, including trichobezoars, may cause obstruction. Severe inflammation of the bowel wall, as in enterotoxemia, can cause paralytic ileus. Enteritis, common to many bacterial (and probably viral and parasitic) pathogens in chinchillas, can often result in intestinal intussusception or rectal prolapse (Figure 6.26). Intussusception and rectal prolapse may often occur concomitantly.



Figure 6.27 Severe hepatic lipidosis in a chinchilla. *Source:* Samantha Darling, Veterinary Medical Teaching Hospital, University of California, Davis.

Hepatic Lipidosis

Hepatic lipidosis (Figure 6.27) is an extremely common finding in chinchillas. It occurs in a wide variety of situations, including anorexia, dental disease, infectious diseases, and pregnancy. Note the pale liver in a chinchilla with enterotoxemia (Figure 6.5). Hepatocyte dysfunction may result in ketosis and hepatoencephalopathy.

Hepatic Rupture

As with guinea pigs, improper handling of struggling animals by unskilled caretakers may result in hepatic rupture and abdominal hemorrhage.

Musculoskeletal System Disorders

The long and thin tibia and the scant fibula make these bones prone to fracture following inappropriate handling, fighting, or mechanical entrapment in cage materials.

Urinary System Disorders

Like other rodents, aged chinchillas develop chronic renal disease. Kidney surfaces are pitted due to interstitial fibrosis and inflammation (Figure 6.28). Uroliths are rare in chinchillas and occur primarily in males. They are usually found in the urinary bladder (Figure 6.29) and less frequently in the urethra. The majority of uroliths are composed of calcium carbonate. Unlike guinea pigs and rabbits, chinchillas do not excrete excess dietary calcium through their kidneys, even when given high amounts of dietary calcium. Semen matrix calculi can occur following retrograde ejaculation of copulatory plugs into the urinary bladder and ureters, with subsequent mineralization. Copulatory plugs may also occlude the urethra (Figure 6.30).

Female Reproductive System Disorders

Unlike guinea pigs, female chinchillas have a large pelvic canal and do not rely on the relaxation of the pubic ligament to allow the birth of their precocious and large neonates. Dystocia is uncommon. Older female chinchillas develop cystic endometrial hyperplasia, hydrometra, and mucometra of one or both uterine horns. Metritis or pyometra,

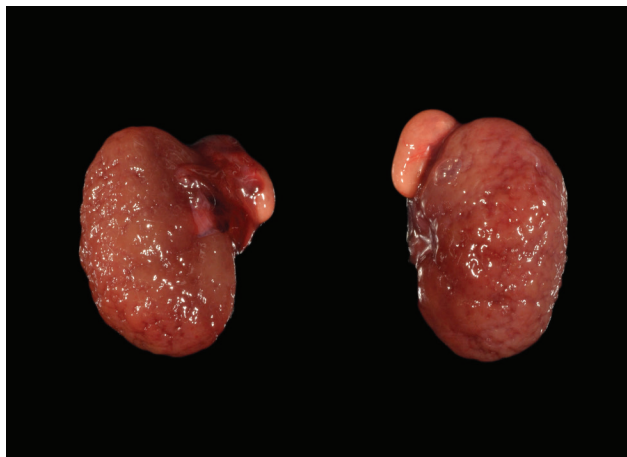


Figure 6.28 Chronic renal disease in an aged chinchilla. *Source:* Marisa Maglaty, Veterinary Medical Teaching Hospital, University of California, Davis.

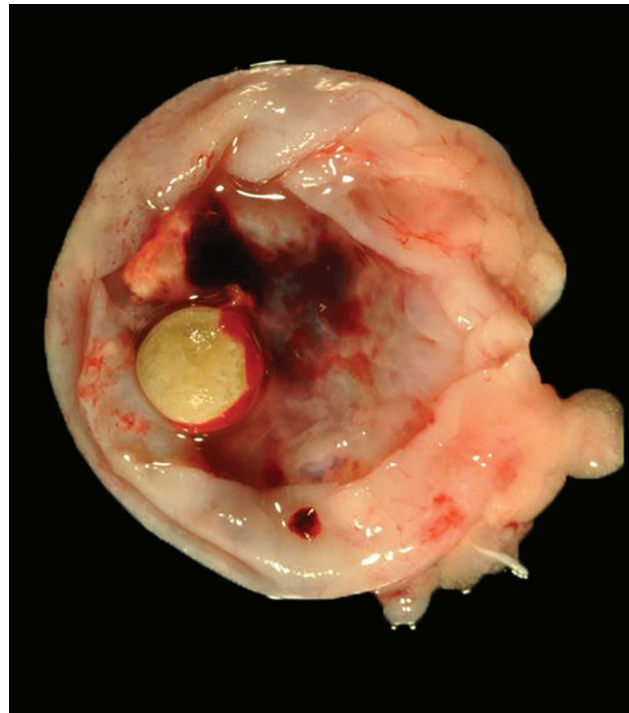


Figure 6.29 Hemorrhagic cystitis in the urinary bladder of a chinchilla with a urolith. *Source:* Dayna Goldsmith, Veterinary Medical Teaching Hospital, University of California, Davis.

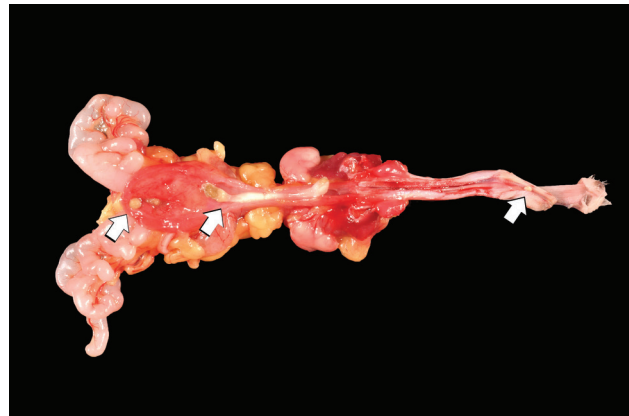


Figure 6.30 Urinary tract of a chinchilla with small uroliths in the bladder and urethra (arrows), and a copulatory plug within the urethra. *Source:* Kerriann Casey, Veterinary Medical Teaching Hospital, University of California, Davis.

including involvement of the uterine stump in females that have undergone ovariectomy, can be associated with a variety of bacteria. These bacteria include *E. coli*, *L. monocytogenes*, *P. multocida*, *P. mirabilis*, *P. aeruginosa*, *S. enterica*, *T. pyogenes*, *Yersinia* sp., and others. Lactating females are prone to intestinal tympany (see above), and

ketosis is suspected in pregnant chinchillas with hepatic lipidosis. As with other rodents and rabbits with hemocho-rial placentation, vascular embolization of trophoblasts is common during pregnancy.

Male Reproductive System Disorders

As noted above, retrograde ejaculation of copulatory plugs into the urinary bladder and ureters may lead to the mineralization and formation of semen-matrix uroliths. A very common finding in male chinchillas is envelopment of the penis with a ring of fur (“fur ring”), which can result in constriction with urinary outflow obstruction and/or paraphimosis. Smegma accumulation may also encase the penis.

Bibliography for Non-neoplastic Organ System Disorders

Fur-Chewing

- Galeano, M.G., Cantarelli, V., Ruiz, R.D., de Cuneo, M.F., & Ponzio, M.F. (2014) Reproductive performance and weaning success in fur-chewing chinchillas (*Chinchilla lanigera*). *Reproductive Biology* 14:213–217.
- Martel, A., Donnelly, T., & Mans, C. (2020) Update on diseases in chinchillas: 2013–2019. *Veterinary Clinics: Exotic Animal Practice* 23:321–335.
- Ponzio, M.F., Monfort, S.L., Busso, J.M., Carlini, V.P., Ruiz, R.D., & de Cuneo, M.F. (2012) Adrenal activity and anxiety-like behavior in fur-chewing chinchillas (*Chinchilla lanigera*). *Hormones and Behavior* 61:758–762.
- Tisljar, M., Janic, D., Grabarevic, Z., Simpraga, B., Marinculic, A., Pinter, L., Janicki, Z., & Nemanic, A. (2002) Stress-induced Cushing’s syndrome in fur-chewing chinchillas. *Acta Veterinaria Hungarica* 50:133–142.
- Vanjonack, W.J. & Johnson, H.D. (1973) Relationship of thyroid and adrenal function to “fur-chewing” in the chinchilla. *Comparative Biochemistry and Physiology* 45A:115–120.

Nervous System and Special Senses Disorders

- Monk, C. (2019) Ocular surface disease in rodents (guinea pigs, mice, rats, chinchillas). *Veterinary Clinics: Exotic Animal Practice* 22:15–26.
- Muller, K. & Eule, J.C. (2014) Ophthalmic disorders observed in pet chinchillas (*Chinchilla lanigera*). *Journal of Exotic Pet Medicine* 23:201–205.
- Ozawa, A., Mans, C., Szabo, Z., & Di Girolamo, N. (2017) Epidemiology of bacterial conjunctivitis in chinchillas (*Chinchilla lanigera*): 49 cases (2005–2015). *Journal of Small Animal Practice* 58:238–245.

Digestive System Disorders

- Crossley, D.A. (2001) Dental disease in chinchillas in the UK. *Journal of Small Animal Practice* 42:12–19.
- Derbaudrenghien, V., Van Caelenberg, A., Hermans, K., Gielen, I., & Martel, A. (2010) Dental pathology in chinchillas. *Vlaams Diergeneeskundig Tijdschrift* 79:345–358.
- Koizumi, I. (2022) Diagnosis and surgical treatment of colonic obstructive foreign bodies in chinchillas (*Chinchilla lanigera*): a case series (2017–2020). *Journal of Veterinary Medical Science* 84:1121–1127.
- Lucerna, R.B., Giaretta, P.R., Tessele, B., de Vargas, A.C., & Barros, C.S.L. (2012) Conjuntivite bacteriana secundaria a doenca dentaria em chinchillas (*Chinchilla lanigera*). *Ciencia Rural, Santa Maria* 42:2034–2036.
- Mans, C. & Jekl, V. (2016) Anatomy and disorders of the oral cavity of chinchillas and degus. *Veterinary Clinics Exotic Animals* 19:843–869.

Urinary System Disorders

- Higbie, C.T., Digeronimo, P.M., Bennett, R.A., Wakamatsu, N., Baumruck, R.A., Stewart, M.A., Rademacher, N., Nevarez, J.G., Magee, A.N., & Langohr, I.M. (2019) Semen-matrix calculi in a juvenile chinchilla (*Chinchilla lanigera*). *Journal of Exotic Pet Medicine* 28:69–75.
- Martel-Arquette, A. & Mans, C. (2016) Urolithiasis in chinchillas: 15 cases (2007 to 2011). *Journal of Small Animal Practice* 57:260–264.

Female Reproductive System Disorders

- Granson, H.J., Carr, A.P., Parker, D., & Davies, J.L. (2011) Cystic endometrial hyperplasia and chronic endometritis in a chinchilla. *Journal of the American Veterinary Medical Association* 239:233–236.
- Yumusak, N., Kutlu, T., & Kutsal, O. (2016) Incidental pulmonary trophoblastic embolism in a chinchilla. *Ankara Universitesi Veteriner Fakultesi Dergisi* 63:211–213.

Neoplasms

Neoplasia is remarkably rare, given the long lifespan of chinchillas. Unlike other species (mouse lymphomas, rat mammary tumors, guinea pig trichoepitheliomas, and rabbit uterine adenocarcinomas), there are no common forms of neoplasia that define the chinchilla. Gastric adenocarcinoma, leiomyosarcoma of the external ear canal, metastatic mammary adenocarcinoma, hemangiosarcoma, neuroblastoma, pulmonary adenocarcinoma, and lymphosarcoma are among the random malignant tumors found in chinchillas. Uterine leiomyoma and lipoma have also been noted.

Bibliography for Neoplasms

Bertram, C.A., Klopfeisch, R., Erickson, N.A., Lubke-Becker, A., & Muller, K. (2019) Leiomyosarcoma of the external ear canal as a cause of otitis externa, media, interna in a chinchilla (*Chinchilla lanigera*). *Journal of Exotic Pet Medicine* 31:13–16.

Greenacre, C.B. (2004) Spontaneous tumors of small mammals. *Veterinary Clinics: Exotic Animal Practice* 7:627–651.

Konell, A.L., Goncalves, K.A., de Souza, R.S., Amora, D.S., Andrade, M.S., & Lange, R.R. (2018) Mammary adenocarcinoma with pulmonary, hepatic and renal metastasis in a chinchilla (*Chinchilla laniger*). *Acta Scientiae Veterinariae* 46 (Suppl):310.

Lucena, R.B., Rissi, D.R., Queiroz, D.M.M., & Barros, C.S.L. (2012) Infiltrative gastric adenocarcinoma in a chinchilla (*Chinchilla lanigera*). *Journal of Veterinary Diagnostic Investigation* 24:797–800.