The mite Demodex spp., which belongs to the Class Arachnida, Order Acarina, lives in hair follicles of all mammals. Demodex canis is the dog follicular mite while in cats it is D. felis (in cats). In dogs Demodex infai is found within sebaceous glands and ducts. D. cornei and gatoi live in the stratum corneum of dogs and cats respectively. They complete their life cycle in about 30 days and the adults will survive for about 21 days. The life cycle of demodex is that an egg (fusiform shaped) develops into 6 legged larvae that then develops into an 8 legged nymph (differentiated from an adult by it lack of an “armor-like” breastplate). This nymph then matures into an adult.

Neonates are thought to acquire mites from their dam/queen via direct skin-to-skin contact during nursing. Direct transmission, other than from dam/queen to the pup/kitten, only occurs with D. gatoi in cats.

In a normal animal the mite does not cause any symptoms. However in some dogs it may cause either localized or generalized disease. There is no universally accepted definition of localized vs generalized disease but recently it has been suggested that with localized disease there are no more than four lesions with a maximum diameter of to 2.5 cm. Demodicosis is also categorized based on age of onset- those less than 12 months of age (18 months in large or giant breeds) are considered juvenile onset while older dogs are considered adult onset. The prognosis is excellent for the localized form either in puppies or adult dogs while the generalized form carries a more guarded prognosis.

Demodex causes disease when there is an overgrowth of the commensal mites either associated with a genetic defect (juvenile onset) or immune suppression (adult onset). In the adult dog, hyperadrenocorticism (iatrogenic or spontaneous), hypothyroidism, leishmaniasis, or chemotherapy are the most identifiable causes of adult onset generalized demodicosis. Note that contrary to what was previously taught, “dogs with adult onset demodicosis have cancer or some other very serious life threatening disease”, in the author’s experience, idiopathy is the rule not the exception. In a retrospective study, less than 50% of the adult onset generalized demodicosis cases had an identifiable underlying cause.

The lesions associated with demodicosis include non pruritic alopecia, scaling, follicular casts, follicular papules/pustules (if a secondary bacterial infection is present), comedones, crusts, erythema, hyperpigmentation, and lichenification. Pruritus is variable but is mild except in cases with a secondary bacterial folliculitis.

Lesions frequently involve the face and/or forelegs and may progress to affect other body sites. Since the lining of the external ear canal is epidermis, demodicosis may cause a bilateral ceruminous otitis externa. As the disease progress dogs may develop a deep bacterial folliculitis and furunculosis and draining tracts. In those cases peripheral lymphadenopathy, lethargy and fever are commonly present. In some patients their presentation is exclusively pododemodicosis. In these cases a deep bacterial folliculitis and furunculosis is frequently present and the feet are swollen and painful leading to lameness.
In contrast to *D. canis* and *cornea*, *D. injai* tends to be associated with a greasy hair coat on the dorsum of the trunk. Many times alopecia is not present and only a low number of mites may be found on skin scrapings. It has been reported that terriers, especially wire haired fox terrier and West Highland white terrier, are at risk of developing this form of demodicosis.

Since demodicosis is a folliculocentric disease it will look identical to follicular lesions caused by a bacterial pyoderma and dermatophytosis. Because of the similarity in appearance these folliculitides, clinical appearance is not an acceptable method to rule-in or rule-out demodicosis. Superficial (for *D. cornea*) and deep skin scrapings (for the other species of demodex) are the most reliable and cost effective method to diagnose demodicosis. In medium or long haired dogs, clip a small “window” in the hair coat to get easier access to the skin and to prevent the loss of the scraped material into the surrounding hair. Skin scrapings are performed with a No. 10 scalpel blade after dulling the blade on the frosted end of the microscope slide.

To perform a deep skin scraping it is best to squeeze the skin prior to and during the scraping to push the mites out of the hair follicles. Scrape the skin in the direction of hair growth until capillary bleeding occurs. When lesions are present on the face or paws the animal should either be sedated before scraping or a hair pluck/trichogram may be performed in an awake animal. Hair plucks are performed with mosquito hemostat forceps that grasp and pull out hairs. It is best to collect hairs from the leading edge of the lesion. To increase your yield, squeeze the skin as you are plucking the hairs and be sure to collect a large number of hairs (50–100). Take the collected hairs and lay them on a slide containing a drop of mineral oil and add a cover slip. Sample multiple sites in each patient. Trichograms, or in cases of pustular demodicosis examination of the exudate, will detect *Demodex* mites in about 85% and 100% of dogs respectively with demodicosis. If the trichogram is negative but other sites are positive, sedation and skin scrapings of the feet should be performed since the mites may be present even if the feet appear alesional. It has been the author’s experience that pododemodicosis, if present, is usually the hardest component of generalized demodicosis to resolve and so should be used as one of the monitoring sites.

Recently it has been reported that applying tape to a skin lesion and then squeezing the skin is as an effective way to identify demodex mites in dogs. A study was performed to confirm this observation. Specifically the study was to evaluate and compare the sensitivities of acetate tape impression deep skin scraping for the diagnosis of canine demodicosis. They concluded that squeezing the skin followed by acetate tape prep was found to be as sensitive as deep skin scraping for the diagnosis of canine demodicosis. Unfortunately the author has not had the same experience. So if you want to do it as a screening test, in difficult to handle dogs or sensitive locations on the dog, be sure to follow it with deep skin scrapings (with sedation if needed) if the tape prep is negative.

Be sure to collect samples from multiple sites and note the site that the sample is collected from since localized disease is treated differently than generalized disease. When examining the slides you need to evaluate for the approximate number of each stage that is present (eggs, larva, nymph and adults). Also note how many of the mites alive vs are dead. These results will be important to compare to future skin scrapings as you are monitoring the dog’s response to therapy. With effective treatment a decreasing number of immature mites and the disappearance of eggs should occur. The number of live mites should also decrease. In all cases of demodicosis be sure to perform an examination of an otic swab. Otodemodicosis is identified by collecting roll swabs from each ear using a cotton swab that has been dipped in
mineral oil. The sample collected is place onto a glass slide that also has a drop of mineral oil on its surface. A cover slip is applied and then the sample is examined.

If samples are collected as described it would be extremely uncommon to miss the presence of demodex mites. Occasionally this may occur, even with properly performed skin scrapings and hair plucks, if the dog has scarring due to chronic disease or because of the thickness of their dermis (therefore the deeper depth of their hair follicle making expulsion of the mite more difficult) (i.e. Shar-Peis). If demodicosis is strongly suspected, but no mites are found on skin scrapings and hair plucks, skin biopsy is recommended to rule in or rule out their presence.

How to treat a dog with demodicosis depends on whether it is localized or generalized. In cases of localized demodicosis, less is best. In many cases, especially juvenile onset, the disease will spontaneously resolve within a couple months. Miticidal therapy is not required unless the disease becomes generalized. Since the progression of localized disease to more generalized form is not influenced by whether the localized form is treated or not, treatment of localized disease is not necessary. However, in the author’s practice “benign” topical treatment is prescribed. This is done so that if the disease does progress, the owner feels that something had been done to try to prevent for occurring. Topical therapy with benzoyl peroxide shampoo and/or gel can theoretically be helpful due to its antibacterial properties and follicular flushing activity. Due to its suppressive effect on the immune system you should avoid using any steroid containing product (topically or systemically) in patients with demodicosis (localized or generalized). Ensuring a proper diet and intestinal deworming program should also be part of the treatment of dogs with demodicosis. To evaluate the effectiveness of treatment, a follow up examination, including repeating skin scrapings, should be performed in 30 days.

Treating a dog with generalized demodicosis requires much more aggressive therapy than localized. Multimodal therapy, a common approach that is used to treat other diseases (eg arthritis, atopic dermatitis or congestive heart failure) will be necessary when treating generalized demodicosis. Acaricidal therapy and treating secondary bacterial infections if present is required for both adult and juvenile onset disease. In adult onset cases attempts should be made to identify and treat the underlying systemic disease.

Dogs with juvenile onset generalized demodicosis, in addition to the above mentioned treatment should be neutered. This is important not only to prevent the propagation of this genetic defect but also estrus may trigger recurrence of clinical disease.

As mentioned previously, in cases of adult onset generalized demodicosis attempts should be made to identify and treat the underlying disease. Evidence shows that successful treatment of an underlying cause increases the likelihood that adult onset demodicosis can be cured. In the author’s practice, diagnostics performed in cases of adult onset generalized demodicosis include a CBC, serum chemistry profile and a urinalysis. Depending on the age of onset, abdominal ultrasound and thoracic radiographs may be included in the minimum data base. Because of the influence that bacterial pyoderma or generalized demodicosis has on evaluating thyroid or adrenal gland disease, evaluation of these organs is delayed until any secondary bacterial infection has been resolved and the demodicosis has improved or is in remission.

Specific treatment of generalized demodicosis is outline in table 1. This table is the result of the most recent consensus guidelines written by an international group of dermatologists. The author has indicated in bold the approach used in his practice.
Since dogs may look normal clinically but still have active disease (as determined by the presence of mites on skin scrapings), treatment must be continued beyond clinical resolution. Parasitic cure is defined as multiple negative skin scrapings, including lack of dead or fragmented mites, on 3 consecutive monthly visits. Skin scrapings should be used to determine the therapeutic end-point. This end point is reached when the dog looks normal clinically and skin scrapings have been performed monthly on the 4-6 most severely affected areas and have been negative for 3 consecutive visits. If during a visit the skin scraping is positive, it is important to compare the number of live and dead mites and the number of each stage of the mite life cycle to the previous visit. An indication of effective treatment is that during therapy the number of live mites found on skin scrapings and the number of immature mites should be reduced from the previous visit. If this doesn’t occur, therapy should be re-examined and possibly changed.

Diagnosis and treatment of demodicosis is an important concept that all small animal practitioners should feel comfortable with. By taking time to thoroughly examine and evaluate the dog, and spending time explaining the disease to the owner, the outcome will usually be successful.

**TABLE 1- SUMMARIZED TREATMENT OF CANINE DEMODICOSIS** (ITEMS IN BOLD ARE THE AUTHOR’S PREFERENCES)

Treatment of a dog with severe generalized disease

1. **Perform cytology and if there is evidence of a deep bacterial skin infection or the dog has been treated previously with antibiotics a bacterial culture and sensitivity. With inflammatory cells and bacteria present, appropriate oral antibiotic therapy is required.**
2. **Use topical therapy with chlorhexidene or benzoyl peroxide shampoo** weekly to possibly **twice weekly. (Unless amitraz is being applied)**
3. There are several treatment options for the treatment of canine demodicosis. The best option will depend on the legalities pertaining to the use of veterinary pharmaceutical products in the country of residence, the finances of the owner and the clinical situation. However, independent of the treatment specifics the dog should be neutered because dogs in need of mite treatment should not be allowed to breed, and the disease may relapse in cycling bitches.

   - **Ivermectin** at an oral dose of 0.3–0.6 mg/kg (0.4 mg/kg) or **moxidectin at 0.2–0.5 mg/kg p.o. daily are further options.** Note: many herding breed dogs have a genetic predisposition to adverse drug reactions involving ivermectin due to a defective MDR-1 gene. This gene is responsible for pumping drugs out of the mammalian’s brain. When this gene is defective, drugs accumulate in the brain leading to adverse events. Gene testing for the defect can help eliminate at risk dogs but there are a number of dogs with adverse effects to ivermectin and an intact MDR-1 gene due to alternative mechanisms. Thus adverse events may still occur in dogs w/normal MDR-1 genes. **Therefore with both drugs, a gradual increase from an initial dose of 0.05 mg/kg to the final dose (of 0.4 mg/kg) within a few days is recommended to identify dogs that cannot tolerate those drugs. Monitoring for neurological adverse effects**
should occur throughout the course of therapy. Ivermectin is the treatment of choice in the author’s practice.

b. Amitraz weekly or every 2 weeks in a concentration of (0.025–0.06%) can be used. Dogs with a medium to long hair coat need to be clipped, and skin should stay dry between rinses to avoid washing off the drug. Rinsing should be performed in well-ventilated areas. The author only uses this therapy if the dog has failed to respond to ivermectin or is a herding breed. Please note that amitraz is EPA registered and doesn’t EVER allow any off label use (label states 1 bottle/2 gallons every 14 days)

c. Milbemycin oxime may be administered orally at a dose of 1–2 mg/kg/day. Moxidectin orally (see below) is in the milbemycin family, is much less expensive than milbemycin, and is used if the dog fails to respond to ivermectin (again a non herding breed)

d. Moxidectin as a spot-on in combination with imidacloprid may be used weekly. This spot-on formulation has a markedly higher success rate in dogs with milder disease.

e. Doramectin weekly at 0.6 mg/kg p.o. or SQ is a possible treatment. A gradual increase from an initial dose of 0.1 mg/kg to the final dose seems prudent to identify dogs that cannot tolerate the drug and will show neurological adverse effects.

So to summarize- this report states that “There is good evidence for the efficacy of weekly amitraz rinses and daily oral macrocyclic lactones such as milbemycin oxime, ivermectin and moxidectin for the treatment of canine demodicosis.”

Other recommendations are

Dogs should be evaluated monthly, and treatment should be continued until 3 consecutive visits with multiple negative skin scrapings have been achieved.

Treat secondary bacterial infections

Factors predisposing to demodicosis, such as malnutrition, endoparasites, endocrine disease, neoplasia and chemotherapy, should be identified and corrected to maximize response to therapy.

In 2015 a study was performed that compared the efficacy of oral Bravecto™ (fluralaner) with the efficacy of topically applied Advocate/Advantage multi® (imidacloprid/moxidectin) for the treatment of generalized demodicosis (GD) in dogs. In this study 16 dogs, all over 12 months of age that had been diagnosed with generalized demodicosis, were randomly assigned to being treated with either 1 dose of fluralaner or 3 doses (q 28 days) of imidacloprid/moxidectin. Dogs were examined (and had skin scrapings) at the beginning of the study and then every 28 days for 12 weeks. The results revealed a 99.8% reduction in mite numbers on Day 28 and 100% on Days 56 and 84 after 1 dose of fluralaner. Mite numbers in the dogs treated topically on three occasions at 28-day intervals with imidacloprid/moxidectin were reduced by 98.0% on Day 28, by 96.5% on Day 56 and by 94.7% on Day 84. The biggest drawback in this study was that the dogs were only followed up for 12 weeks so that we don’t know the relapse rate, nor did the imidacloprid/moxidectin ever achieve complete remission. Since juvenile onset GD has a higher success rate than adult onset GD it would have been beneficial to stratify the dogs into 2 groups based on age of onset.
Also in 2015 a study \textsuperscript{iii} evaluating the efficacy of fluralaner for the treatment of canine demodicosis was reported. One hundred sixty three dogs of different breeds with GD. Animals were divided into two age groups based on age at presentation: group one, 2–18 months (62.6%) and group two, over 2 years of age (37.4%). Dogs were treated with fluralaner (25 mg/kg) orally, twice three months apart. Skin scraping and/or hair plucking were performed 1, 2 and 3 months after the first fluralaner administration. The overall response to therapy was 100%. The majority of dogs (87.1%) had negative skin scrapings at the 30 day exam. Twenty-one individuals (12.9%) (all belonging to group two) needed two months after the initial fluralaner administration to achieve negative scrapings. As with the previous study, no long term follow up was performed so relapse rate is unknown.


\textsuperscript{iii} Karas-Tecza J, Dawidowicz J Efficacy of fluralaner for the treatment of canine demodicosis, Veterinary Dermatology, 26, 307