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■ **Eastern Equine Encephalitis in Alpacas**

There is nothing more exhilarating than seeing a vigorous female cria up on long wobbly legs starting to explore her world. Her owner had called me about the birth and I arrived soon after to help greet her. So it was doubly heartbreaking to learn just a couple of weeks later, that the same beautiful animal suddenly sickened in front of her owner's watchful eyes and, in spite of the best vet care possible, died within a few hours. This is the horrible scenario that at one point this past fall (2005) seemed to be happening at farms all around us, and no one could tell us the cause. Our local vets felt as hopeless as we did. In spite of their best intensive care, their previously healthy patients (one had been given a clean bill of health just the day before being admitted to the vet hospital) were dying. Another sick alpaca had to be treated as best as possible and sent home for observation because there was no room at the overflowing hospital.

At first, it was a relief when the first diagnosis of Eastern Equine Encephalitis (EEE) was finally confirmed. At least we knew the name of the enemy. But that did little to console us when we realized we were all vulnerable to this mosquito-borne illness. There is no vaccine that has been tested in alpacas. All we could do at the time was to reduce the mosquito population on our farms as much as possible and hope for an early frost. This is the first time I have been eager to see my garden turn black!

Little did we know how close we were to the disease. We later learned that almost 1/3 of our herd had EEE titers – meaning they had been exposed to the virus – but luckily, none had gotten sick.

However, we did know that if there were to be any chance of real protection for our herds for next fall, we would have to act fast.

This is where local breeders, our local vets, the New England Alpaca Owners and Breeders Association (NEAOBA), and Dr. Bedenice at Tufts University stepped up to the plate. The first communication with Dr. Bedenice was by e-mail. Even though she was at a conference halfway across the country, she responded almost immediately to our plea for help.

What followed was an expediently-assembled research project funded by the Alpaca Research Foundation and also with donated funds from NEAOBA. Results from this study, “Humoral (Antibody) Response to EEE Vaccination in Healthy Alpacas: 12/01/05-11/30/06” are now emerging. As of this writing, Dr. Bedenice is working on a paper to report the results of this study, with a view to rapid publication in the peer-reviewed literature and wide dissemination to the veterinary community.

I recently caught up with Dr. Bedenice by phone at Tufts. Here is an excerpt of our discussion:

What exactly is EEE and what symptoms have you seen in alpacas?

EEE is an emerging blood-borne, fatal central nervous system (brain) disease in South American camelids (llamas and alpacas). It's caused by the EEE virus, a member of the family *Togaviridae*, genus *Alpha-virus*, that is transmitted by mosquitoes and leads to illness predominantly in horses and occasionally



The Alpaca Research Foundation (ARF), in conjunction with Morris Animal Foundation (MAF) and other groups in the llama and alpaca communities, provides funding grants to veterinarians and scientists engaged in research that has the potential to improve the health and well-being of our animals. *Alpacas Magazine* is pleased to bring you another in a series of interviews with the researchers carrying on this important work.



humans. However, cases in swine, cattle, sheep, emus, and mice have also been described. The life cycle of the virus mainly involves birds of freshwater swamps and is believed to be maintained by the mosquito *Culiseta melanura*, while other mosquito vectors are typically responsible for spreading the virus beyond the swamp environment to non-avian species.

Can alpacas pass on the virus to other animals?

Based on our current knowledge, the answer is “no.” Mammals (horses, alpacas, etc.) are considered to be “dead-end hosts,” which means that even when they are infected, the amount of virus in their blood stream is not high enough that mosquitoes who feed on them can infect other animals they feed on later. This is in contrast to infected birds, which tend to maintain a high viral load. However, no one has yet performed studies assessing the actual level of viremia of EEE-infected alpacas. Direct transmission of the disease between alpacas is not believed possible.

Why haven't we seen EEE before in camelids?

Hard to say... I'm sure that many people didn't even test for this disease in alpacas in the past because of a low index of suspicion. Ten years ago,

we did not test for West Nile Virus either! It is also plausible that the EEE virus may have changed or “mutated” over the years, which now allows infection in camelids or that the environmental conditions are more favorable for the virus nowadays (as it likes wet conditions). Further research in this field is required to answer this question.

How come EEE suddenly showed up in alpacas in New Hampshire for the first time in 2005?

This is actually not quite accurate, as the first confirmed cases were documented in 2004. So far all affected animals were from the East Coast, with four from New Hampshire, two from New Jersey, and one each from New York, North Carolina, and Massachusetts.

Where (and when) is EEE likely to show up in future years?

The incidence of EEE infection in alpacas is a reflection of the prevalence and regional distribution of EEE virus in general. Each state laboratory maintains detailed records of all reported cases in humans, birds, alpacas, horses, etc., over the years. I believe that this disease will remain a problem in the future and reflects how common the mosquito vector is.

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How is it different from West Nile Virus?

Both EEE and WNV are “arboviruses” i.e. transmitted by mosquitoes, but they fall into different virus “families” (Flaviviridae – WNV vs. Togaviridae – EEE). The problem is that the clinical symptoms of viral encephalitis in camelids may be non-specific and additional tests are usually required to establish an “etiological/causative” diagnosis.

Based on a recent review by my colleague, Dr. Nolen-Walston, we know that clinical signs of EEE infection in llamas and alpacas is consistent with brain (CNS) disease and may include dullness, fever, incoordination, inability to rise, persistent tilting of the head, mentally inappropriate behavior, seizures, rapid eye movement, and a swan-like backward flexion (opisthotonus) of the head and neck. To date, most reported cases have involved young alpacas.

EEE is known to carry a worse outcome than WNV in other species (75-100% death rate in affected horses). However, some reports have shown death rates due to WNV to be as high as 83% in camelids, which approaches what we see for EEE (8/9 reported camelid EEE cases died last year = 89%). We have to remember, though, that both WNV and EEE are fairly “newly-recognized dis-

eases” in llamas and alpacas, which may skew our appreciation of the outcome, since many cases may have gone undiagnosed in the past.

Have any alpacas recovered from EEE?

Currently there is only one report of a 3½ week old cria recovering from symptoms consistent with EEE. This alpaca cria was EEE serum positive (she had the virus antibodies in her blood), even though her dam had no antibodies (so we know the mother had not passed the virus or protection to it along to her cria). Other possible causes of the illness were also ruled out, although to be certain that it was EEE that caused the symptoms, the cria’s brain tissue would have had to be examined during a necropsy, which happily was not needed in this case.

What can we do to protect our alpacas?

This is a tricky question, since research in this field is still limited. I generally approach the control of this disease from two perspectives: vector (mosquito) control and possible vaccination.

Mosquito Control

- Eliminate mosquito breeding grounds.
- Stable alpacas and llamas during the high transmission time periods of dawn and dusk during the fall (all current EEE cases in camelids occurred between August and October on the East Coast).

Vaccination:

- Consider vaccinating alpacas with a killed Equine Vaccine if they are living in an area with high EEE virus exposure. Vaccination is considered protective against EEE in horses and emus, based on challenge studies (given the live virus). But it is important to remember that the efficacy of EEE vaccination CANNOT be established based on serological (antibody) responses alone.
- As a first step, we have recently evaluated serum-antibody production in alpacas following three intramuscular vaccinations with an equine vaccine marketed through Intervet (Encevac™) at four-week intervals.

How will you know that the horse vaccine is working to prevent infection with EEE?



So far, I can share the following results:

- The Encevac™ vaccine appears to be quite safe in adult alpacas, as we did not see any side effects in the 39 adult, non-pregnant animals we repeatedly vaccinated.
- The antibody titers following EEE vaccination appear to rise more slowly in alpacas than in horses and are also overall lower. However, young animals (<2 years) showed an earlier seroresponse than older animals. Following three consecutive vaccinations, four weeks apart, 93% of young alpacas had positive EEE serum titers in our study (although some of the titer levels stayed quite low). The response in older animals was not as consistent.
- Compared to the WNV vaccine, the EEE vaccine does not fare quite as well with respect to sero-responses. However, it is difficult to predict whether the level of seroresponse actually coincides with the level of protection of a vaccine. Studies in horses have shown that previously vaccinated animals may be protected against the virus, even if their antibody titers at the time of virus exposure are negative. We call this an “amnesic” response. Unfortunately, only virus challenge studies, where vaccinated and non-vaccinated alpacas are exposed to EEE, would definitely answer that question.

When did you get interested in working with camelids and why?

Well, first of all, it wasn't in Germany, where I grew up and entered vet school! It was after I visited the U.S. in 1996, where my brother happened to live near Boston. I quickly became fascinated with the

work performed at the nearby Large Animal Hospital at Tufts University. I returned to Tufts after I graduated and was very attracted to working with llamas and alpacas – there's just something about them that draws me to them. Of course, I love horses, too, but I was in the right place at the right time, as there were already established horse specialists at Tufts, but none yet specifically for camelids.

Another huge incentive was, and still is, that I like challenges – and llamas and alpacas are certainly that! For one thing, they hide disease so well, and for another, there is so much basic research still to be done before we understand their needs. For example, we can treat them with medication, which we know works in other animals, but we have to extrapolate the doses based on studies in related species, because we don't always have the specific information for llamas and alpacas. This often works OK, but can also be far off and controversial. This kind of off-label “extrapolation” would never be acceptable in human medicine, but it's the best that we can do right now, besides continuing to improve our “evidence-based” knowledge.

It is also more difficult to gauge a camelid's response to treatment because they tend to have very strong stress reactions, more like cats, when you bring them into a vet exam room.

Another part of camelid care is how positive I find my interactions with alpaca and llama owners. In general, such owners are educated, forthcoming with careful observations, and compassionate towards the care of their animals. They appreciate our efforts and very much support our pursuit of solutions to the problems presented by the animals they bring to us.

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I also love to encourage vets in training (...I actually never stop learning as a vet myself) to become involved and experience camelid medicine first hand. I feel such a thrill when I see our students and house officers develop a similar fascination for camelids to my own. Overall, I hope that this type of early exposure, which is something from which most vets practicing today weren't able to benefit, will facilitate a high comfort and skill level when caring for llamas and alpacas.

As an Assistant Professor, do you do much in the way of clinical practice, or is all your work in research and teaching?

My responsibilities are 50% research, teaching, delivering lectures, and attending conferences and 50% clinical work – seeing patients referred to us by their primary veterinarians. I don't do any regular/primary vet care, which is a little sad as that means that I rarely see healthy crias – only the sick ones. But I think that working through the client's local vet and keeping them involved is crucial to ensure the best possible follow-up care.

A 50/50 split is difficult to maintain long term and most people in my position eventually gravitate to focus mainly on clinical care, or on research. However, I like both aspects so much that I can't bear to have to choose – at least not yet! Much of my research activities, like this EEE study and my current work on BVD (bovine viral diarrhea) in camelids, start as questions that come up in my clinical practice that need to be solved. The EEE study was great because of the close collaboration between me at Tufts, the owners, the vets in the field (led by Dr. Amy Bright) who administered the vaccine and collected the blood samples, and Jack Dibb of the University of New Hampshire, a breeder who coordinated the sampling and analysis and who compiled the raw data. Things don't come together that well very often!

What do you see yourself working on in the future?

I am looking forward to doing more research that involves client participation. Many of the studies, like those investigating emerging natural diseases and studies to evaluate effective treatment and medication dosages, are quite non-invasive, so could be done in the real world. However my ultimate goal is

to establish a research herd. That would really help – there is so much that could be done! Of course, that would completely depend on raising the funds, which would be substantial, especially for the new infrastructure that would be needed like a barn, etc. If that ever does happen, then I can see myself focusing more and more on camelids – there is something incredibly special about them!

I can't believe you have time for much of anything else, but do you have any hobbies?

I do, actually! I recently moved to a new house with some pasture land and am delighted to report that I have two alpaca males settled in there. They are so serene and relaxing to have around! Their quarters are not quite finished, but are relatively more advanced than those of the humans!

I have a long-time interest in art and love to paint and draw, but it's been a while since I have used these "talents" for anything more than the presentation of scientific data.

My main hobby right now is to train the younger of my two German Shepherd dogs. He has shown great enthusiasm for one of the fastest-growing working dog sports in the U.S. called "Schutzhund," which originated in Europe as a test for working German Shepherds. The dogs are carefully trained to compete in obedience, scent tracking, and protection exercises.

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Note: The alpacas pictured here are two of the crias, Glory and Kona, who succumbed to the EEE virus at a young age. Used by permission of their owners.