One of the newer discoveries in equine acute gastrointestinal disorders has been the increase in reports of coronavirus disease in horses. (Costa et al. 2012) Risk factors, duration of fecal shedding (there is nasal shedding in <50% of cases), and methods of spread are still unknown. What is apparent is that adult horses are commonly affected in many areas of the United States. Anorexia, fever, and leukopenia are pronounced. Colic and diarrhea are sporadic. Although there are isolated cases on a farm, outbreaks are common. Diagnosis is by clinical signs and PCR testing of feces. This beta-coronavirus has at least two different strains both of which are detected by the currently available PCR. Serologic testing has been performed on herd outbreaks. Treatment is mostly supportive fluids, antipyretics that have low intestinal toxicity, gastric protectants, etc. for those with diarrhea. Mortality is low but 3 to 5 days may lapse before the horses begin to eat. On rare occasion, an infected horse with diarrhea may die of fatal neurologic signs (primary enteric hyperammonemia).

Methicillin resistant Staphylococcus aureus (MRSA) infections are emerging (since the late 1990s) as a significant pathogen in horses and humans. How this highly invasive, easily transmitted and highly antibiotic resistant Staphylococcus evolved is unknown but selective genes are responsible for the previously mentioned features of the organism. There are many strains of the organism and some can be spread from horse to human or vice versa. There is one strain that is particularly common in the horse but is uncommon in humans unless they have had horse contact. MRSA is carried in the nasal cavity and infections at surgical sites, wounds and catheters have been the primary clinical problem in both horses and humans. Hospital acquired MRSA are often resistant to the majority of antibiotics. Some highly resistant strains are susceptible to amikacin and some to chloramphenicol but a few are only susceptible to Vancomycin. Amikacin, if the organism is susceptible to it, has many advantages including concentration dependent effect with a post antibiotic killing effect. It can also be given by regional perfusion for wound and joint infections or successfully nebulized in the rare MRSA pneumonia case. Hospital acquired infections tend to have a greater resistance pattern than do community acquired infections, some of which remain sensitive to TMP/S or Doxycycline and many other antibiotics, but are always resistant to Beta lactam antibiotics. We now wear disposable gloves when examining any catheter, incision etc. and use nolvasan scrub which is more effective in preventing MRSA infections than is betadine. Hand washing and proper equipment disinfection with Nolvasan or Omega respectively will be helpful in decreasing infections.

Equine Proliferative Enteopathy (EPE), caused by Lawsonia intracellularis is certainly an emerging sporadic disease among weanling age foals. Clinical signs are weight loss, edema from
low albumin which occurs in all foals, diarrhea in approximately 50% and colic in some. Ultrasound examination of the abdomen will show thickened small intestinal walls. Confirmation of the diagnosis is by combination of both serology and fecal PCR. Serology has a low specificity (a high percentage of foals and adults on a farm with a clinical case of EPE are seropositive) and fecal PCR has only a moderate sensitivity unless multiple samples are submitted. Submission of both feces and rectal swab will improve sensitivity of testing. Efforts should be made to rule out other causes, eg. parasites, R. equi, Salmonella etc. of intestinal disease in 4-11 month old foals. EPE may very rarely affect equines older than 11 months. Treatment is intravenous tetracycline followed by Doxycycline or minocycline given orally. Other antimicrobials, ie.chloamphenicol, have also been used with success. I prefer not to use macrolides because of the risk of antibiotic induced colitis. Epidemiology of the disease is unknown but it appears that many wildlife species shed the organism in their feces. A commercially available swine vaccine, administered per rectum, could be used if a farm had an endemic problem with EPE. There are approximately 10% of foals with clinical disease that do not respond, even with the best of care. The reason is unknown. There is also a rare acute syndrome with inflammation of the intestine, DIC and death that is associated with Lawsonia. It is not unusual for Lawsonia cases to also have marked parasite infection.

Salmonella infections are “old” hat” but newer strains are emerging. Some of these strains are highly drug resistant. Salmonella oranienburg has been of particular concern given the multidrug-resistance and evidence of high morbidity associated with infection. Recommendations for management of horses recovering from clinical salmonellosis include: 1) isolate the horse, if possible, until repeated 3 to 5 fecal samples are negative. During this time, maintain all practices, i.e., separate stall, cleaning equipment etc., necessary to decrease environmental fecal contamination. Manure from the horse should be composted and the trailer/van that was used to transport the horse should be spray washed, dried, and a disinfectant applied, e.g., omega 2) if isolation is not feasible, the horse can be turned into pasture with other healthy horses; (historically, baring unusually heavy fecal contamination from a shedding horse to other horses, or unless there are ill horses or over-stocking on the farm, sending a shedder back to a farm/stable has on a very, very rare occasion caused clinical disease in other horses); 3) humans should wear protective boot covers or individual boots, and wash their hands after being in contact with a known Salmonella positive horse; 4) avoid oral antibiotic treatments in the shedding horse if possible or sudden feed changes during the “heavy” shedding period. Most horses shed Salmonella in amounts that allow culture detection for < 3 months. PCR testing is highly sensitive for detecting carriers but PCR positive horses are unlikely to be important risk for transmission unless they are also culture positive. “point of care” testing using a lateral flow ELISA on 12-18 hr pre-incubated broth has good sensitivity and excellent specificity and can be used by private hospitals the shorten the time needed for diagnosis. Pulse
field gel electrophoresis can be used to help identify if the isolate is a “hospital acquired” infection.

Potomac horse fever (*Neorickettsia risticii*) seems to have a higher incidence of laminitis than salmonellosis in adult horses, has different risk factors (seasonal, geographic, no concurrent illness, etc.), but clinically looks very much like salmonellosis. There is a specific treatment for Potomac horse fever, tetracycline intravenously, and the quicker it is given in the course of the disease the better the prognosis! Many horses have any combination of fever, protein losing enteropathy and/or laminitis without diarrhea. The clinical disease appears to be uncommon in weanling in my experience. There are several strains of the organism and it is an intracellular organism explaining only modest efficacy of the current vaccine.

*Clostridium difficile* colitis occurs most commonly during or following administration of antibiotics; often occurring 3-4 days after antibiotic therapy is started. Withholding feed also appears to be a risk factor. Colic and ileus may be more common with *C. difficile* colitis than with salmonellosis or potomac horse fever (personal opinion), and *C. difficile* colitis may have a higher incidence at referral centers and brood mare farms than other equine facilities. Specific treatments are oral metronidazole, Bio-Sponge,® and gastric administration of *fecal/cecal cocktails*. Metronidazole-resistant strains occur, but have mostly been found on the West coast. Other antibiotics may be used intravenously or intramuscularly to protect against bacterial translocation during severe bowel inflammation; but if used, should be antimicrobials and dosages that minimize their effect on normal intestinal flora!! An equine origin hyperimmune plasma is available for either prophylactic (eg. following colic surgery) or therapeutic use in horses (Lake immunogenics). (See Chang YF. et.al Vet Sci 2013.) Both *C. difficile* and *C. perfringes* type A are often blamed in neonatal foal diarrhea outbreaks but cause and effect are many times hard to prove and preventive treatments have been frustrating.

*Rhodococcus equi* continues to be a significant infectious disease with increasing prevalence of “disease” on farms with high density of foals and dusty conditions. There is now some evidence that foal to foal transmission via aerosol *may* exist, which may explain why some farms with lush pastures may still have a relatively high incidence of disease when mares and foals are stabled at night. There does not appear to be a vaccine on the immediate horizon although vaccination of mares or oral vaccination of foals might eventually be proven to be successful. Chemoprophylactic treatments with either Azithromycin or gallium salts have now been shown to be mostly unsuccessful and may have side effects and increase antimicrobial resistance (Burton et al 2013). There is now further proof that administration of hyperimmune plasma is helpful as a prophylaxis. Although unproven, it may be that determination of economic value of hyperimmune plasma might be estimated by either number of cases of R. equi pneumonia the previous year, foal density or percentage of mares that culture fecal positive early in the foaling season. Clarithromycin or Azithromycin combined with rifampicin is the recommended standard of care treatment. Rifampicin will interfere with macrolide absorption and treatments could be separated by 2 hours if possible but will increase labor needs and handing of the foal.
Tulathromycin is not effective in-vitro but gamithromycin is effective for most isolates in-vitro. The combination of doxycycline and rifampicin may cause hepatotoxicity and hepatic failure and should not be used! (Fenner 2013) Many asymptomatic foals with abscess up to 10 cm may recover without treatment making it difficult to determine by routine ultrasound screening, which foals need to be treated. Zylexis was not proven to be of benefit as a prophylaxis in a field study.

**Equine herpes virus-1** (EHV-1) is, for multiple reasons, a very problematic infectious disease in the horse. EHV-1 may cause several different clinical syndromes, some of which result in epidemics of disease following the arrival of an infected horse on the premise. The virus can also be maintained in carrier animals, which may then result in either self-disease (most likely) and/or spread at some later point in time. Spread of the virus is mostly horse to horse as it’s persistence in the environment is relatively short. Transmission is typically via infected nasal secretions, although fetal membranes and placental fluid from the aborted fetus are also highly infective. After direct contact, the virus first colonizes the nasal mucosa and then replicates in regional lymph nodes by 1-3 days. This is followed by viremia for 3-14 days (depending upon the strain). From day 2 or 3 post-infection to day 7, there should be high virus load in nasal secretions. Following the acute disease, horses may “silently” harbor the virus as a latent infection in peripheral nerves or lymphoid tissue and reactivation may occur following an environmental stressor or very high doses of steroids resulting in clinical disease (e.g., abortion) in the pregnant carrier, or possible environmental spread. Clinical diseases include: (1) upper respiratory disease with fever, nasal discharge and lymphadenopathy, often in weanling foals, (2) rarely pulmonary disease with severe pulmonary vasculitis and thrombosis, (3) abortion with both placental and fetal infection in most cases, but only placental infection in other cases, (4) outbreaks of neurologic disease most commonly associated with EHV-1 having a mutation in the polymerase gene, high levels of viremia and CNS vasculitis, and (5) neonatal sepsis, involving multiple organs (liver, lung, and even gut), and severe neutropenia and lymphopenia.

Treatment for the neurologic disease should include supportive care, DMSO, Plavix and Aspirin and corticosteroids in progressive cases. The i.v. administration of ganciclovir at 2.5 mg/kg every 8 h for 24 h followed by maintenance dosing of 2.5 mg/kg every 12 h would maintain effective ganciclovir serum concentrations for EHV-1 in most horses (Carmichael 2013).

**Equine herpes virus-5** (EHV-5) is a cause of equine multinodular pulmonary fibrosis(EMNPF); a disease that may appear clinically similar to “heaves” but has fever, lymphopenia and elevated fibrinogen and, of course ultrasonographic and radiographic evidence of pulmonary fibrosis. (Williams KJ 2013, 2014) On rare occasion an infected horse has uveitis. Treatments include Valacyclovir as the target treatment but minocycline and even corticosteroids have been used with some apparent success. The general success of treatment is low. More recently EHV-5 has been associated with Lymphosarcoma and treatment with antivirals resulted in complete resolution of the disease! (Werf, K 2013, 2014)
**Eastern encephalitis and West Nile Virus** infections continue to plague horses in the U.S. but virtually always in improperly or unvaccinated horses! Continued vaccination is necessary for both diseases and vaccines appear highly efficacious!

**Leptospirosis** is caused by a highly invasive, spiral bacteria in the genus *Leptospira*. In North American horses, *Leptospira pomona kennewicki* is the prominent incidental (pathologic) serovar and the skunk is the most common maintenance host of this serovar. *Leptospira bratislava* is considered by most researchers to be the host adapted serovar of the horse. Pathogenic *Leptospira* infections in the horse appear to have organ tropism for either the reproductive tract of the female, kidney or eye. Infection may result in placentitis and abortion, acute renal failure, or hematuria and most importantly, uveitis. *Leptospira pomona* abortions account for approximately 13% of bacterial abortions in mares in endemic regions. Serovar Pomona is responsible for most of the *Leptospira* abortions in North America, but Grippotyphosa and Harjo have also been reported. Most abortions are late term (> 9 months) and rarely a live foal may be born ill due to leptospirosis. *Leptospira* organisms are commonly found in the placenta, umbilical cord, and kidney and liver of the infected fetus. Although more than 1 mare on a farm may abort due to Leptospira infection, it is rare for an epidemic of abortions to occur. Some mares that are infected do not abort.Aborting mares and other recently infected horses are believed to shed *L. pomona* in the urine for approximately 2-3 months. A small number of horses on the farm experiencing 1 or more *Leptospira* abortions may develop uveitis weeks later. Occasionally, *L. pomona* may cause fever and acute renal failure in the horse. The kidneys are swollen due to tubulointerstitial nephritis and the urine may have pyuria without visible bacteria. On rare occasion, multiple young horses may be affected with fever and acute renal failure following *Leptospira* infection. The most important clinical disease associated with *L. pomona* infection in the adult horse is recurrent uveitis/keratitis. The strong association between ERU and *L. pomona* dates back to the early 1950’s with a general belief that it was an immune-mediated disease with antibody (IgG and IgA) against certain *Leptospira* antigens cross-reacting against equine uveal tissue, lens, cornea and possibly retina. Since 2000, there have been numerous scientific publications confirming live *Leptospira* in the uveal tissue, aqueous or vitreous fluid of horses with RU. High antibody concentration to *L. pomona* in the aqueous humour compared to serum titers also suggest persistent local antigenic stimulation. Survival of the organism in the face of high ocular antibody indicates an absence of cells/molecules, e.g., complement, involved in bacterial clearance, suggesting ocular immune privilege similar to the central nervous system. The recurrent episodes of the disease may be related to a Th1 response of autoreactivity following mimicry and inter- and/or intra-molecular epitope spreading. Genetic factors are likely involved in the disease process, helping to explain why only some horses infected with leptospira develop uveitis. Appaloosas are thought to be genetically predisposed.

Diagnosis of Leptospira abortion is best accomplished by fluorescent antibody testing (FAT) or immunohistochemistry of the placenta, umbilical cord, or fetal liver and kidney. The sensitivity and specificity of the FAT on those tissues are nearly 100%. Examination of silver stained kidney samples in horses with renal disease does not have a high accuracy, as there may
be false negative and false positive (likely due to non-pathogenic serovars). Marked increases in serum titers often accompany Leptospira abortions or acute renal failure, but may be low with recurrent uveitis because of the chronic localized infection. Acute *L. pomona* infections will often cause marked elevations in several serovars, but the non-infecting serovar titers will decline much more quickly over several weeks than the titers to the actual infecting serovar. Serovar specific FAT of a urine sample or dried urine sediment can be helpful in diagnosis and determination of continual shedding. Collection of the second voided urine sample following furosemide administration may improve sensitivity of this test. Serology, culture or PCR of aqueous fluid may be the only way to confirm Leptospira associated uveitis. Administration of antibiotics would be indicated for horses with fever and acute renal failure caused by leptospirosis. Ticarcillin was used successfully in 1 horse with acute renal failure. Other antibiotics that *Leptospira* may be sensitive to include: penicillin, ampicillin, cephlosporins, enrofloxacin, tetracycline and doxycycline. A previous attempts to decrease urine shedding in horses with acute or subacute *Leptospira* infection by using oxytetracycline, penicillin G and streptomycin was surprisingly not effective? Fluid therapy would be indicated as supportive treatment of acute renal failure.

There have been a variety of treatments for ERU, e.g., corticosteroids and cyclosporine, used in hopes of decreasing the inflammatory response, but these have generally provided only temporary relief and most affected horses either become blind or have the eye removed because of intractable and persistent pain. Vitrectomy with inoculation of a gentamicin lavage has been reported to be a successful treatment in Europe. The mounting evidence that active *L. pomona* infections are present in many of the horses with ERU is one of a couple possible explanations for our inability to cure most cases. If *Leptospira* is believed to be associated with a case of ERU, it seems prudent that an effort should be directed towards treating the possible chronic infection. Unfortunately, antibacterial treatment of ocular leptospirosis may not be easy since the blood ocular barrier inhibits movement of antimicrobials from the plasma into the eye. Even with inflammation, some interference may persist. In healthy ponies, doxycycline could not be found (limit of detection < 0.3 µg/ml) in the aqueous humour after 21 day treatment with 5 mg/kg q 12 hours. In recent *in vitro* work, enrofloxacin demonstrated low MIC and MBC (< 0.30 µg/ml) against strains of *L. pomona*. Peak aqueous levels of enrofloxacin are 0.32 ug/ml after repeated intravenous dosing with 7.5 mg/kg Baytril 100. Topical antibiotics may reach adequate levels in the aqueous but typically diffuse poorly into the vitreous. Antimicrobial treatments may be inhibited by biofilm on the organism. Vaccination (extra-label) against *L. pomona* is sometimes performed on farms with endemic abortions and/or a high rate of uveitis and anecdotically seems to be successful!.

Although certainly not an emerging disease, **strangles** remains as one of the most significant infectious diseases in the horse. PCR from a guttural pouch wash provides a potentially useful adjunct and is superior to culture of nasopharyngeal swabs in the detection of asymptomatic carriers of S. equi following outbreaks of strangles. Nasal swabs are not as sensitive! It is always
important to investigate the guttural pouches in adult horses suspected to have *Strep. equi* infection. Survival of *Strep. equi* in the environment was short in a recent study (Wesse 2009), ranging from < 1 to 3 d. but may be much longer under ideal conditions. There was no effect of rain or surface type, eg. wood etc., but there was an effect of sunlight. Outdoor survival of *S. equi* is poor, and prolonged quarantine of outdoor areas, particularly areas exposed to the sun, is probably unnecessary. The Strep M protein ELISA can be useful in confirming cases of purpura hemorrhagica, although horses that had been vaccinated with an attenuated-live intranasal *S. equi* vaccine between 1 and 3 years previously may have a serum SeM-specific antibody titer > or = 1:1,600. (Boyle) Treatment of carrier horses consist of; removing chondroids, infusing the guttural pouch with penicillin gel and systemic antibiotic therapy for 1-3 weeks. Do not vaccinate carrier horses.

*Actinobacillus equuli* is a gram negative pleomorphic rod which normally inhabits the equine oral cavity, pharynx and gastrointestinal tract. As an equine pathogen, it is considered opportunistic, being most commonly associated with foals with failure of passive transfer or possibly "carried" throughout the body by parasites or foreign bodies? It is the most common organism isolated from primary peritonitis. It is also commonly found in septic foals born to mares with the MRLS, where it may also cause pericarditis and pleuritis in affected adults. It is the most common isolate I have cultured from horses with endocarditis. It is variably sensitive to a wide variety of antibiotics.

**Lyme disease** is a common tick-borne infectious disease in parts of North America, Europe and Asia. It is caused by a helical shaped gram negative spirochete *Borrelia burgdorferi*. In North America only, *B. burgdorferi* sensu stricto causes Lyme disease. *Ixodes scapularis/I. pacificus, Ixodes ricinus* and *Ixodes persulacatus* are the most important vectors in North America, Europe and Asia, respectively. Once tick feeding begins, the *Borrelia* organism begins both up and down regulation of certain genes to allow transmission and survival. OspA may be down-regulated, while other surface proteins (OspE, OspF and Vis-E/C6), that are in low concentration in the tick gut are up-regulated during transmission to enhance immune invasion in mammals. A large percentage of adult horses in the more eastern parts of the Northeast and Mid-Atlantic United States are or have been infected with *B. burgdorferi* and the geographic distribution appears to be increasing. Infection may also common in Wisconsin and Minnesota in the USA. Seroprevalence in horses in many other parts of the United States has not been reported, but would be expected to fluctuate in a manner similar to that seen with the human Lyme disease. The most common reported signs believed to be associated with Borrelia infection included: shifting lameness, stiffness, behavioral changes and inability to perform work. Neurologic dysfunction and disease attributed to *Borrelia* infection have been reported. Other clinical syndromes that we have documented to be sometimes associated with Borrelia infection include uveitis (2 cases), dermal pseudolymphoma and multiple cases of synovitis. The incidence of clinical disease compared to infection is low. The most commonly used antibiotics for treating Lyme disease in the equine (Tetracyclines) have anti-inflammatory properties which may cause
symptomatic improvement in many stiff horses regardless of Lyme status. *A. phagocytophilia* is found concurrently with *B. burgdorferi* in many *Ixodes* ticks resulting in dual infection in many horses. Heavy tick infection and local cellulitis has resulted in low grade fever in some horses.

Lyme disease is diagnosed on the basis of the horse being from an endemic area, compatible clinical signs, ruling out other causes for these signs, and a high enzyme-linked immunosorbent assay (ELISA) titer, other serologic test or positive western blot (WB) test results for anti-*B. burgdorferi* antibodies. I do not recommend treating horses based solely upon a positive test! The multiplex assay provides information on duration of infection (eg. increased OspC suggestion infection within the past 4 months) and can be helpful in prognosticating treatment success. There are a seemingly increasing number of unvaccinated horses with high OspA antibody that appear to have clinical disease?

The two most commonly used antibiotics for treating Lyme disease in horses are tetracycline, given intravenously, and doxycycline or minocycline, given orally. Horses with what are often believed to be more typical signs of Lyme disease (e.g., chronic stiffness, lameness, and hyperesthesia) are most frequently treated with doxycycline (10 mg/kg, PO, every 12 hours). Duration of treatment is often 1 month, but this duration of treatment is mostly empirical. Diarrhea develops in a low percentage of doxycycline treated horses. Tetracycline (6.6-11.0 mg/kg, intravenously [IV], every 24 hours) may be more efficacious because of higher tissue concentrations of IV tetracycline as opposed to poorly absorbed doxycycline given orally. In the experimental infection studies, Oxytetracycline given intravenously was superior to doxycycline given orally. Oxytetracycline should not be administered in high doses or for prolonged periods if dehydration is present or there is preexisting renal dysfunction! Minocycline (4mg/kg Q 12 hr. P.O.) achieves higher concentrations in the CSF and aqueous than does Doxycycline and has been used in treating horses. Ceftiofur was moderately successful in eliminating the infection in experimental ponies. Intravenous penicillin is used for some cases of neuroborreliosis. Metronidazole is used in some refractory cases. Ponies have been protected by vaccination with an OspA vaccine, but a vaccine approved for use in horses is not commercially available. Efficacy of administration of the canine vaccines in the horse is unknown.

Other emerging infectious agents (new and old) of possible significance include Rhinitis virus and both EHV-2 and EHV-5 as respiratory pathogens in the horse. *Theileria equi* infected horses in Missouri, Texas and elsewhere in 2009-2010. Although not emerging diseases, certain infectious disorders such as rabies and influenza may suddenly appear in a geographic area.

**Besnoitiosis** is caused by infection with protozoan parasites *Besnoitia* spp, which are cyst-forming coccidian parasites that affect multiple host species worldwide. *Besnoitia bennetti* is the species known to infect equids. Currently the only reported cases of equine besnoitiosis in North America have been in donkeys. The *Besnoitia* life cycle in other species involves both a definitive and an intermediate host. Finding the definitive host in equine besnoitiosis have so far been unsuccessful. In species with known life cycles, infective oocysts are ingested by the
intermediate host and develop into thick-walled connective tissue cysts containing millions of bradyzoite-stage parasites. Clinical disease in donkeys is characterized by the development of a miliary dermatitis of pinpoint parasitic cysts in the skin, mucous membranes, and conjunctiva. The skin over the muzzle, nares, ears, perineum and medial thigh appears to be preferentially affected, as does the vulvar mucosa in infected female donkeys. One of the most unique features of besnoitiosis is the development of ‘scleral pearls,’ which are cysts along the limbal margin of the sclera. Cysts have also been found in the testicles, nasopharynx, larynx, trachea and esophagus of infected donkeys, but the extensive internal involvement noted in other intermediate host species has not been documented in equids.

In a recent investigation of donkey herds in the Northeastern United States, young animals (average age 2.7 years) were at increased risk for development of besnoitiosis when compared to older individuals. (Ness et al JAVMA 2013) The most common lesions in infected donkeys were cysts in the nares (100%) and scleral pearls 83%). Only 50% of infected animals displayed nasopharyngeal/laryngeal lesions on endoscopy. Some infected animals remain otherwise healthy, while others become cachexic and debilitated as a result of the disease. The reason for this difference in host response to infection is unknown, but similar clinical subtypes are observed with bovine besnoitiosis. The current gold standard for diagnosing besnoitiosis in donkeys is histologic identification of *Besnoitia* cysts within the dermis of individuals displaying clinical lesions, generally achieved via skin biopsy. Studies evaluating the utility of serologic assays similar to those used to diagnose besnoitiosis in cattle are currently underway, and may become available in the near future. Several treatments have been attempted but so far none are proven effective.