About the Lab

Tufts Equine Respiratory Health Lab is the only place in New England offering a complete respiratory workup for equine athletes of all levels, from 10-goal old ponies and D3 Pony Club horses to future Derby winners, Grand Prix dressage horses and beloved backyard companions.

Our Lung Function Laboratory was the first in the country to develop routine lung function testing in clinical patients. We are at the forefront of understanding, diagnosing and treating horses with inflammatory airway disease (IAD). By utilizing our advanced equipment and expertise, we can test and evaluate before developing a comprehensive plan to help your horse return to its peak performance.

As pioneers in the industry, we have successfully demonstrated a link between respiratory viruses and equine asthma, explored the significance of coughs in different populations of horses, established the importance of biomarkers in the diagnosis of equine asthma, quantified the effect of albuterol on treadmill performance and airway reactivity, and examined lung function in aging horses.

Today, Tufts Equine Respiratory Lab has grown to offer expertise in the following services:

- Complete respiratory workup
- Lung function testing
- Airway reactivity test
- Chest radiographs
- Comprehensive bronchoscopy
- Bronchoalveolar lavage with cytologic analysis on-site by a recognized expert
- Dynamic treadmill endoscopy
- Comprehensive bronchoscopy
- Thoracic ultrasound

Tufts Equine Respiratory Lab offers the most advanced and effective diagnosis and treatment for your horse.
Tufts Equine Respiratory Lab

Tufts Equine Respiratory Lab is New England’s only center to offer the same lung function testing for horses that human athletes receive for subtle performance abnormalities, or if they have chronic asthma and are searching for a better quality of life.

Horses naturally have an enormous respiratory reserve. Unless they are working at peak aerobic capacity, they are unlikely to ever even begin to tap into their reserves; this explains why horses are intrinsically elite athletes, but it also indicates their propensity to harbor a subclinical, silent respiratory disease without anyone noticing, until it shows itself through symptoms such as a disturbing cough or exercise intolerance. Lung function is the most critical component of the diagnosis and treatment of equine asthma because while bronchoalveolar lavage (BAL) is important and useful diagnostically, it only tells us about inflammation in the lungs and not how well the lungs and airways are doing their job.

Lung function testing with bronchoprovocation or bronchodilation can help us measure your horse’s response to treatment and predict their exercise capacity. Some horses, like early asthmatics, show no recognizable signs of lung inflammation but have profound airway hyperreactivity that can only be detected with lung function. We can use lung function testing on horses that are not responding adequately to treatment to determine which medications result in improved function (seen as decreased resistance).

Bronchoalveolar lavage cytology does not always reflect improvements in disease state, but lung function testing is far more sensitive and useful to track the response to treatment and is completely non-invasive.

For horses with chronic respiratory disease or issues unrelated to equine asthma, or for horses who do not respond to standard treatment, we use chest radiographs to rule out problems such as fibrotic disease, bronchiectasis and bullae.

Our high-powered Philips x-ray tube allows us to take radiographs of an adult horse’s chest, which cannot be done in the field with a portable machine. This enables us to rule out other diseases if the horse has a chronic respiratory issue or problem other than equine asthma. We seldom take radiographs of horses that suffer from the low-grade IAD form of equine asthma, however, as even the most powerful x-ray techniques cannot pick up significant abnormalities in the smallest airways.

While endoscopy of the upper airways and trachea can easily be done in the field, at Tufts, we have the ability to also perform a full bronchoscopy to examine the majority of the branching airways, which allows us to probe for unusual causes of airway inflammation, such as foreign bodies, and to sample from multiple different areas in the lower airways. We can also look at the level of edema or inflammation in the lower airways and for any anatomical or structural deformities. We routinely perform the BAL using bronchoscopy, which allows us to sample both sides of the lungs (since both sides are not always the same, the cellular picture does not always match), and correlate the macroscopically visible structures with what we see microscopically during the cytology.

© 2018 Dr. Melissa Mazan
Our pulmonology specialists perform the lung function testing and bronchoscopic BAL, as well as read the cytology, allowing us to create a complete picture that helps us diagnose and develop a comprehensive and effective treatment plan designed specifically for your horse.

If lung function testing, BAL and radiographs suggest that equine asthma may not be the correct diagnosis, or if we have concerns that there is a more significant problem in the parenchyma (tissue) of the lung, our ultrasonographers will assist us to do an ultrasound-guided lung biopsy. Our pathologists can read the biopsy on-site while working with our lung experts to put the clinical findings together for a full diagnosis.

Whether you bring us your horse or send us your BAL for cytological analysis, our mission is to help all horses reach their respiratory potential.

**Equine Asthma**

Many of you have probably heard of the severe respiratory disease known as heaves, otherwise known as recurrent airway obstruction (RAO) and inflammatory airway disease (IAD). There are also other names to describe airway conditions including allergic airway disease, small airway disease and COPD.

All of these diseases fall under the spectrum of equine asthma, and horses with any form of equine asthma have airway inflammation that causes the signs you recognize, ranging from poor performance to a cough, nasal discharge or overt respiratory distress.

We’ve known for a very long time that the horse’s environment is responsible for most of the ills that beset our equine companions. Aristotle noted that horses ‘at pasture [were] largely free from disease’; while Louise Hill Curth described a condition known as ‘heartache’, which was probably heaves in ‘A plaine and easie waie to remedie a horse’: Equine Medicine in Early Modern England.

Equine asthma, whether IAD or heaves, is usually treatable, but not necessarily curable. It can take a lifetime of management, but with an accurate diagnosis, proper treatment and environmental improvements, most horses can return to athletic function.

**Signs**

It’s easy to recognize when a horse has a flare-up of heaves. It is the horse that everyone in the barn knows, the one who gets a bad batch of hay and then stands in the stall with nostrils flaring and sides heaving, desperately trying to get air. It can be a little harder to recognize a horse with IAD, especially because these two diseases are on a continuum of severity, and
horses with mild heaves can sometimes look pretty normal. So, what does a horse with IAD look like? It depends on what the horse does for a living.

Racehorses, whether they are Thoroughbreds, Quarter Horses or barrel racers, need every bit of oxygen they can get. Even the smallest amount of respiratory disease can show up as decreased performance without any other distinguishing signs such as a cough, nasal discharge or visibly abnormal breathing effort. The classic description of a racehorse with IAD is that he ‘quit at the ¾ mark.’ The Kentucky Derby horse that loses by a length (which seems like a huge amount in a race) is only about 0.15 seconds slower than the horse ahead of him, and he may well have lost because he had IAD.

IAD shows up in young racehorses and can be very difficult to diagnose without advanced techniques. High-goal polo ponies also live on the oxygen edge. During a seven-minute chukka, polo ponies can cover three miles at a gallop going up to 30 miles per hour. As with racehorses, you may never hear them cough, and it’s unlikely that they’ll have nasal discharge, but they might get ridden off as you gallop with an opponent towards the ball. High-level event horses, competitive endurance horses and jumpers may also have poor performance without showing other identifiable signs of respiratory impairment. Occasionally, however, the rider or trainer may note that it takes longer for the horse’s respiratory rate to return to normal after peak exercise, or that the horse ‘blows’ more than other horses after exercise.

Horses have been blessed with an extraordinarily large respiratory reserve. Have you ever wondered why we race horses and not cattle, who after all, are about the same size as horses? It is most likely because horses have lungs that are almost twice the size of cattle lungs. This means that unless horses are at their peak performance, they probably don’t need all the oxygen that their lungs can deliver. Consequently, we tend not to notice the beginning stages of IAD.

IAD can even go undetected in a high-level dressage horse, a hunter/jumper or reining horse for a long time. It isn’t until these athletes start to cough or have a noticeable nasal discharge that we look for evidence of respiratory disease. Many riders will describe how their horse practically pulls them out of the saddle with a cough at the beginning of a ride. Unfortunately, because IAD is so common, many people think it is normal for a horse to cough at the beginning of a ride. Coughing is common but not necessarily normal. Coughing is a sign that all is not well with the respiratory system, and the most common cause in horses is IAD. An astute rider or trainer may notice earlier signs, which can include: trouble getting a horse on the bit or even noticing that a horse is making a respiratory noise when he’s on the bit; taking down a rail; swapping leads; or just a generalized ‘lack of brilliance’.
All of these non-specific signs can be a warning that something is wrong with the horse’s respiratory system.

Although heaves are classically a disease of stabled horses, we find that many IAD horses in the New England area have exacerbations of the disease in the late spring and summer. They tend to have the most severe signs when it is hot and moist. Many horses also show worse signs with the advent of pollen season, especially when evergreens surround their pastures. Symptoms are also often worse when indoor arenas become dusty or barn management practices cause more dust in the air.

**Causes**

Both IAD and heaves are diseases caused by poor air quality and unfortunately, agricultural environments and farms are replete with organic dust and other particulates that can cause profound irritation to the airways of horses, humans and other creatures sharing the environment. This irritation results in inflammation in even non-allergic individuals. Many cases of IAD show no evidence of actual allergic disease, whereas the more severe disease, heaves, has a clear allergic component. Although horses with mild-to-moderate heaves can appear normal in a physical examination when they are kept in a dust-free environment, clinical heaves, with obvious breathing effort, cough and nasal discharge, can easily be induced in these individuals by exposing them to moldy hay.

Horses with IAD, on the other hand, often have no signs of allergies at all. Instead, IAD in these horses is similar to what is called occupational asthma in people. Although we commonly think of asthma as an allergic disease in people, in reality, many agricultural workers or those who live or work in dusty environments – such as livestock farms, cotton factories, woodworking shops or landscaping – can develop asthma without any underlying allergic disorder. For these workers, the particulates, endotoxin and beta glucan levels are so high that the airways naturally produce a profound inflammatory response. Unfortunately for horses, their occupations often include living in environments that are neither good for horse lungs nor human lungs.

Even the best of hay contains mold spores

Even the best barns are laden with endotoxins (bits and pieces of dead, gram-negative bacteria that still triggers profound inflammation in the lungs), beta-glucans from molds, mites and other insects, and ammonia gas from urine. Viable bacteria can be found in the breathable air in many indoor arenas. If you were to feed your horse the best quality hay that money could buy, it would still be full of mold spores that do not cause infection but that are small enough to be inhaled into the tiniest airways in the lungs where they trigger airway inflammation. Tractors in some barns, rely on diesel engines to pull manure
or hay wagons. This fuel is particularly problematic because the particulates that it contains cause oxidative damage to the lungs. Air pollution does the same thing and unfortunately, because of the way the winds blow, even seemingly pristine areas of New England can be affected by pollution that originates, for example, in the Midwest.

If you have ever wondered what this is doing to your own lungs, you would be wise to be a little worried. We encourage all of our clients to clean up their barns to keep their horses and themselves healthy. A study from our laboratory (Mazan 2009) showed that people who spend 10 or more hours in a horse barn have a markedly increased risk (up to 10 times) of developing respiratory symptoms compatible with asthma. The high particulate, endotoxin, beta-glucan and ammonia level that hurts horses' lungs also triggers inflammation in our lungs.

Recent work from our laboratory (Houtsma 2015), as well as evidence from other researchers, suggests that a disease, similar to the situation in children, can trigger or worsen disease. It may be that certain horses have an innate susceptibility to IAD. In this case, anything that sets off inflammation, such as viral respiratory disease, can put in motion a vicious spiral that results in IAD or heaves.

**Pathogenesis and Pathophysiology**

The common link between heaves and IAD is airway inflammation. In horses with heaves, the inflammation that we see on a lung wash, otherwise known as a bronchoalveolar lavage or BAL (see below) is due to cells called neutrophils, whereas in horses with IAD, the culprits may be neutrophils, mast cells or a combination of the two. Horses rarely have eosinophils as the inciting inflammatory cells, unlike cats and humans with asthma who commonly have high levels of eosinophils in their airways. We know far more about what happens on a microscopic basis in the lower airways of horses with heaves than we do about horses with IAD. Horses with heaves develop increases in airway smooth muscle, fibrous tissue, epithelial tissue and mucus, all of which contributes to the marked bronchoconstriction (narrowing of the airways) that results in abnormal breathing and air hunger. Although we can reverse bronchospasm due to abnormal smooth muscle contraction with drugs such as albuterol, and we can reduce mucus production with the use of corticosteroids (see below), the fibrosis and epithelial thickening are difficult to reverse, and abnormal lung function in horses with overt heaves can still be detected even when the horses are in remission.

When horses have chronic, long-standing airway dysfunction, as with heaves, they often develop abnormal breathing patterns at rest. The time that they spend breathing out (expiration) is usually prolonged, and they often develop hypertrophied external abdominal oblique muscles that are used for pushing air out of the lungs. Just as a bodybuilder develops an
exaggerated look from overuse of specific muscles, a horse with heaves develops a heave line from muscular overuse during breathing. Some horses become quite thin when they have chronic heaves. We know from studies in our laboratory that these horses burn the same amount of calories that they would if they were trotting all day and all night. It would be impossible for them to eat enough to satisfy their caloric needs.

While we know less about the pathology of IAD, we do know that they produce excessive amounts of mucus, which we see both on endoscopy and BAL cytology. Because most horses with IAD have airway hyperreactivity, we can surmise that they have either overly active airway smooth muscle or excessive amounts of smooth muscle in their airways. A recent study showed that airways of a vast majority of actively racing horses have neutrophilic inflammation of the small airways as well as smooth muscle hyperplasia. The distribution suggests that the inciting agent is inhaled; this correlates well with the clinical data showing that airway inflammation is associated with high levels of particulates, including endotoxin, beta glucans, ammonia and other airway irritants.
Why does it matter?
It’s not hard to understand why heaves matters for a horse. When a heaves-affected horse can hardly walk from the barn to the paddock, it’s clear that the horse has a poor quality of life and no athletic ability. But what about the horse with IAD? If it were just a cough or an occasional drippy nose, IAD would be annoying but nothing else. The problem, though, is that IAD affects athletic function. Horses with constricted airways have trouble getting enough air out of their airways, and this eventually leads to uneven ventilation of the lungs. Parts of the lungs get enough oxygen, and other parts do not. This leads to hypoxemia (low blood oxygen levels) during exercise. Low blood oxygen levels in turn lead to fatigue, which can contribute to injury in addition to poor performance. Moreover, there is emerging evidence that shows horses with IAD have a much higher risk of eventually developing the more severe disease, heaves. If we recognize and treat IAD at an early stage, we have a better chance of preventing severe and debilitating diseases later in life.

Lung Function Testing
The job of the lungs is to deliver oxygen to the body and to take the carbon dioxide, which is a product of normal metabolism, away from the body – this is termed lung function. Lung function testing does exactly what the term says – it evaluates how well the lung functions in delivering air to and from the lungs. In overt heaves, it is easy to demonstrate abnormal lung function with standard methods. In IAD, abnormalities in lung function are often so subtle that it is necessary to challenge the airways to detect any abnormalities. Although many people diagnose IAD with bronchoalveolar lavage cytology alone, lung function testing is the only way to know how affected the horse’s lungs are currently and how effective treatment has been in improving your horse’s ability to get air in and out of the lungs.

Analysis of lung function usually requires us to measure the flow and pressure in the lung. The classic way of doing this is with a pneumotach, a device for measuring flow as it comes out the nose, and an esophageal balloon. This technique isn’t very well suited to clinical work, which is why most owners or trainers have never heard of it.

At Tufts Equine Respiratory Health Lab, we have two different methods of non-invasive lung function testing: Forced Oscillatory Mechanics, or FOM, and Open Plethysmography, which is referred to as Open Pleth created by Dr. Andy Hoffman. Both techniques allow us to effectively measure lung function in the athletic horse. FOM is the technique most commonly used in the hospital, where we push pulses of compressed room air into the horse’s lungs and then look to see what happens to that air as it comes back to our sensors – a pneumotach (airflow measuring device) and pressure transducers. If the horse’s airways are constricted or full of mucus, the pulses of air that bounce back to us are smaller and out of sync with the pulses that went in. We use this information to get a measurement of respiratory resistance, known as RRS, which in turn gives us a number that we can use to say whether the horse’s respiratory system has difficulty moving air. Open Pleth also gives us an idea of what the respiratory system resistance is, but it does it in a slightly different way. With Open Pleth, we still measure airflow at the nose with a pneumotach, but we also record a theoretical airflow at the chest. To do this,
we place elastic bands that are capable of transmitting a signal around the horse’s chest and abdomen, and we translate the expansion and contraction of those bands as the horse breathes in and out, first into volume changes and then into flow. We then compare the true flow at the nose with the calculated flow from the bands – the delta flow, or the difference between the two, is a surrogate for respiratory resistance.

Although the measurements that we can get from these systems are more sensitive than the classical esophageal balloon and pneumotach method, they will not detect the subtle differences in airway caliber and reactivity, which can make a racehorse a tenth of a second slower or interfere with a jumper’s energy levels enough to make her take down a rail. To figure out if there are relatively subtle changes in the airways that can cause performance issues, we need to do histamine bronchoprovocation tests. Horses have very large airways, and small changes in very large airways are hard to detect with any form of lung function testing. If we challenge the airways by having the horse breathe in a small amount of histamine, which causes temporary bronchoconstriction, it is much easier for us to detect abnormalities. Why is this? Fluid dynamics, which also describe airflow through tubes like the bronchi and bronchioles in the respiratory tract, are governed by something called Poiseuille’s Law. This law states that the resistance through a tube is equal to the inverse of the radius to the 4th power. Think about this with an imaginary bronchiole that has a radius of 1.0 cm. One raised to the 4th power is still one. So, my resistance is 1.0 cm/H2O/l/s (read this as one centimeter of water per liter per second). Now, let’s imagine that this bronchiole is in a horse with IAD and I’ve just given that horse some histamine. The bronchiole has constricted and its radius is now 0.84 cm in diameter. If I raise 0.84 to the 4th power and then take the inverse of that, I suddenly have doubled my airway resistance. That’s a change that can really affect your horse’s ability to compete, and it’s the type of increase in resistance that we can see in real life.

**Bronchoalveolar Lavage (BAL)**
The bronchoalveolar lavage (BAL) allows us to see deep within the horse’s lungs to determine if there is inflammation and if so, what the inflammation looks like. The BAL is sometimes called a lung wash because we literally wash the smallest airways and alveoli (tiny lung sacs where oxygen is exchanged) with sterile saline. When we suction back that fluid, we bring cells and mucus out of the lung, and then we make a cytology of that fluid (a slide that we can look at under the microscope). The BAL can be done blindly in the field with a specialized silicone tube, called a Bivona BAL tube. This is a very useful technique and is practical for ambulatory veterinarians. At Cummings, we prefer to do a full bronchoscopy. This allows us to examine all...
the airways as we obtain the BAL, and it also allows us to examine the upper airway to
determine if there are any abnormalities that may be contributing to a horse’s cough or nasal
discharge in addition to IAD.

Clients and referring veterinarians sometimes ask us why we don’t just do a tracheal aspirate
using a regular endoscope, which is a very simple procedure and doesn’t require any specialized
equipment. The answer is that this method takes cells from what we term the ‘tracheal puddle’
toward the end of the trachea, and multiple studies have shown that what we see in the
tracheal puddle does not reflect what we see in the BAL. Quite simply, the two methods are not
equivalent, and the tracheal aspirate is inferior to the BAL if we want to know what is going on
in the small airways, which is what we care about with IAD horses.

**BAL Technique**
The bronchoalveolar lavage is best used in cases where we suspect that the disease we are
looking for is diffuse, and when we are not planning to culture the fluid. It is most commonly
used for suspected IAD or heaves, but can also be useful for interstitial pneumonia, fungal
pneumonia or silicosis, for example.

Your veterinarian will listen to your horse’s heart with a stethoscope before performing the
BAL. Although the BAL is common and safe, we prefer not to perform it on a horse with cardiac
arrhythmia or a very high respiratory rate. Your veterinarian will also warn you that your horse
is likely to cough a lot during the procedure and while it may sound alarming, it should be
expected. Before performing the BAL, your veterinarian will heavily sedate your horse. There
are several reasons why heavy sedation is essential: firstly, we are aware that when people
experience a BAL, they don’t feel pain, but they do report feeling panicky. We want to sedate
the horse to keep it from feeling any unpleasant sensations; secondly, we need the tube to go
into the horse’s trachea and not the esophagus, so we have to stretch the head out and
encourage the horse to leave the airway open; and finally, we want to be able to wedge the
tube or endoscope firmly in the lower airway so that we get a true picture of the cells in that
area. It will look to you as though your veterinarian is using a lot of sterile fluid to wash the
lungs – and it is a lot. We use half a liter of sterile fluid to do a BAL. However, your horse’s lungs
are enormous and any fluid that is not suctioned back is rapidly absorbed by the great veins in
the lungs, so there is no risk of drowning your horse, as clients sometimes fear. By using a large,
standard amount of fluid, we make sure that we get repeatable results that can be compared to
known standards – this is critical for a correct diagnosis. Once your veterinarian has instilled
and suctioned back the full 500mls of fluid, they will place it on ice to keep the cells happy until
they are back at the clinic where slides can be made or the fluid can be sent to our laboratory
for analysis.

**BAL Cytology**
Horses normally have a scant amount of mucus in their lower airways, along with alveolar
macrophages, lymphocytes and a scant number of neutrophils, mast cells and eosinophil.
Alveolar macrophages are the predominant cells in the airways of most mammals, including humans, but they only account for approximately 60% of the total cell population in horses; lymphocytes are the other heavy hitters, accounting for about 40% of the total cell population in the lungs. Normal horses have less than 5% neutrophils, less than 2% mast cells and less than 0.5% eosinophils. Let’s talk for a minute about what these cells do.

We think of alveolar macrophages as the normal cells of the lung. Alveolar macrophages are the ‘clean-up’ cells that are part of the innate immune system. They recognize particulates that don’t belong in the lung and get rid of those particulates, including bacteria, before they can cause damage. In the picture below here you can see one of the worst offenders in equine lungs – a spore from one of the many fungi that are found in even the best hay. This is not an infection, but more like a foreign body to which the horse’s lungs are mounting an inflammatory response. Lymphocytes are rare in the lower lungs of most species other than horses. They are important to immune function but have an important role in the adaptive immune system, which the body uses to recognize specific pathogens and have what is termed ‘memory’. Neutrophils are scarce in the healthy lung of any species, but proliferate in horses with heaves/RAO and also more severe or chronic IAD. Mast cells are important in allergic diseases, and although their staining characteristics are very aesthetically pleasing, the beautifully staining purple granules are the very things that cause many of the symptoms associated with respiratory allergies, including bronchospasm and cough. Eosinophils are rare in the healthy horse but can be seen more frequently in the BALF in the summertime, or in horses that have intestinal parasites. Less commonly, we see goblet cells, which produce mucus and both ciliated and non-ciliated epithelial cells. Epithelial cells should be rare to absent in the normal BALF: we see them more frequently in horses with cough or who have had viral respiratory disease in the recent past.

Although some laboratories suggest straining BALF to remove mucus, our laboratory prefers not to, as microscopic analysis of the mucus itself can be important to the diagnosis of disease, and mucus often has trapped particulates such as pollen and mold spores, allowing the cytologist to detect the original problem.
Diagnosis
Clinical history is critical to diagnosis. The horse with overt heaves, or recurrent airway obstruction (RAO) will have a history of having had a recurrent (hence the name) breathing problem, characterized by outwardly evident difficulty breathing which often results in a visible ‘heave line’ which is the product of chronic increased expiratory effort, cough and nasal discharge. An astute owner will note that the signs usually get better when the horse is kept out of the stable, and a ‘bad’ batch of hay (usually meaning that the hay has mold) can throw the horse into a full-blown exacerbation of disease. In the South, and during warm, humid months in more northern areas of the country, high mold or pollen levels in the air can produce similar signs in horses that are kept outside, so-called Summer Pasture Associated Recurrent Airway Obstruction, or SPARAO. The history in a horse with IAD may be much more subtle, ranging from loss of speed to occasional cough, mucoid nasal discharge, reluctance to come onto the bit, taking down rails when jumping, failure to swap leads, or any number of relatively subtle signs that may not seem to be related to the respiratory system. Both horses with RAO and those with IAD often have a history of living in a barn with: hay stored overhead, stalls that are close to a poorly-ventilated indoor arena, plentiful pine trees during pollen season, blowers used to clean aisleways or multiple other sources of dust. Poorly ventilated barns may feel comfortable in the ‘people areas’ such as the large aisleways but have high ammonia levels in the stalls.

On physical examination, the horse with heaves in exacerbation often has flared nostrils, and auscultation of the chest reveals both crackles and wheezes. Gentle manipulation of the trachea usually produces a cough. Severely affected horses are often thin, as their work of breathing is considerable. Horses with IAD, on the other hand, often appear completely normal on physical examination. It may be necessary to have the horse rebreathe into a bag to increase the breathing effort, to hear any abnormalities on auscultation of the chest.

Diagnosis on the farm
Severe cases of heaves are easy to recognize on the farm. The combination of a recurrent and escalating history of coughing and breathing difficulty, especially in the wintertime when the horse is in the barn, along with a physical examination during exacerbation, is often diagnostic in and of itself. Your veterinarian may choose to do a blood test called an SAA (serum amyloid A) which our group along with other researchers, has shown can help to distinguish between equine asthma and infectious respiratory disease. Endoscopy may show large amounts of mucus in the airways, and both tracheal aspirate and BAL will reveal a majority of neutrophils in the fluid. If your veterinarian carries a spacer, such as the Aerohippus and albuterol, they will bronchodilate your horse to provide immediate relief – this can also help in diagnosis because unless the heaves-affected horse also has fibrosis in the lung, the bronchospasm that is causing the difficult breathing is at least partially reversible. Another drug that is commonly used in spasmodic colic, Buscopan, can also be used to induce temporary bronchodilation, although it should be used with caution in horses that have a high heart rate.
IAD is more difficult to diagnose in the field. Your veterinarian will start by making sure that your horse does not appear to have any infectious disease. Horses with IAD do not have a fever but will have a bright eye and be interested in life and food. Horses with infectious respiratory disease, such as equine influenza or pneumonia, usually look sick. Your veterinarian may choose to do a rebreathing test to search for abnormal lung sounds or cough, may do an SAA blood test, and may do an endoscopy to look for excessive mucus in the trachea and rule out upper airway causes of cough, such as epiglottic entrapment or sinus infection. If the history and physical examination are highly suggestive of IAD, the next step is a BAL on the farm. We offer a consultation service for BAL cytology (see below – LINK), so that your veterinarian can have access to our experts on diagnosis and treatment of equine asthma in addition to a cytologic read of the fluid.

Diagnosing my barn
There are some very low-tech and inexpensive ways to help you determine whether your barn provides a healthy environment for your horse’s lungs. First, walk around as though you were seeing the barn for the very first time. Look at where your horse’s stall is located with respect to the rest of the barn. Is it near areas of high traffic, such as the tack room, barn manager’s office, or wash stall, where more dust can get kicked up? Look at the ceilings and the corners. Are there a lot of cobwebs, dust, areas of the barn that cause you to cough? Wait for a sunny day and walk into the aisleways and stalls right after the barn is cleaned, and then one, two, three and four hours after. Do you see any beams of sunlight? If you do, remember that you can’t really see light – what you see is the motes of dust suspended in the air. You really shouldn’t be able to do that. Now, observe how people work and move around in the barn. When the stalls are cleaned, do the barn people throw the bedding up against the wall? That's a really good way to kick dust into the air. Are they using leaf blowers to clean the aisleways or are there diesel fuel tractors pulling manure wagons down the aisleways? Again, these are great ways to ensure dust and other particulates are in the air. Now, look at the type of bedding and hay you use and how the hay is stored. Multiple studies have shown that shavings are better than straw for bedding, but that pelleted bedding or shredded paper provides an even more dust-free environment than shavings. Hay stored overhead or adjacent to the stalls is one of the leading ways for mold spores to get in the air that your horse is breathing. After you finish looking at the barn itself, take a detailed look at the indoor arena. Is it dusty when you are riding? Is your horse’s stall near the indoor arena? For anyone who has spent a lifetime riding in indoor arenas, it will come as no surprise that unless they are well managed, they can be a significant source of particulates and even culturable bacteria that can be inhaled by both you and your horse.

It is certainly useful to do a more in-depth analysis of barn air quality if you have a problem with multiple horses. Smoke tests to look at air movement, particulate and dust measurement and ammonia levels can all be done and monitored to help you determine whether you are effective in your management. If you are thinking of building a new barn or renovating an old one, it is worth hiring a qualified barn architect to make sure that ventilation is excellent. This will save you money in veterinary costs in the long term.
Treatment Options
The three arms of treatment for equine asthma include immediate relief of bronchospasm, long-term treatment for inflammation and environmental remediation.

Bronchodilation
The best therapy for immediate relief of bronchospasm is inhaled albuterol, which is a beta-2 agonist (B2-AR) bronchodilator, more simply described as a drug that works on the sympathetic branch of the autonomic nervous system and has reasonable specificity for the beta-2 receptor, which is found in the airways. The sympathetic nervous system is the well-recognized ‘fight or flight’ pathway, so it is important to use drugs that have a narrow spectrum, allowing us to avoid the other side effects of this class of drugs such as high heart rate, sweating, poor gastrointestinal function and anxiety. Horses do not absorb albuterol orally, and clenbuterol, an orally administered B2-AR, does not act rapidly enough to be considered a ‘rescue’ drug, and, because it is administered systemically rather than by inhalation, can have multiple undesirable side effects. Other inhaled B2-ARs include the long-acting salmeterol and the even more specific drug, levalbuterol, marketed as Xopenex.

After the immediate relief of bronchospasm, other drugs can also be employed for bronchodilation, including ipratropium bromide, which acts by inhibiting the parasympathetic branch of the autonomic nervous system. This drug is less commonly used in equine practice but can be useful in horses with chronic or severe disease.

Inhaled bronchodilators, like inhaled corticosteroids (see below) must be used with either a spacer device such as the Aerohippus TM or a nebulizer such as the Flexineb TM. Unfortunately, pressurized metered dose inhalers (traditional asthma ‘puffers’) are becoming less common on the market, as the industry moves toward powdered formulations. Albuterol can be easily nebulized to horses and is relatively inexpensive in a liquid form, but the few corticosteroids that are available for nebulization in humans are still quite expensive. Dexamethasone in nebulized form has been examined in healthy horses, but not in horses with RAO. It has the advantage of being inexpensive.

Corticosteroids
The longer-term pharmacologic approach is with corticosteroids to decrease inflammation. Corticosteroids can be given by a systemic route, usually oral or intramuscular administration, or by an inhaled route. Choosing which route usually depends on cost (inhaled steroids are generally quite expensive), the severity of disease and other concomitant diseases. Horses with Equine Metabolic Disease (EMS) or Equine Cushing’s Disease (ECD), for instance, are usually not good candidates for systemic corticosteroid therapy except for life-threatening situations. Horses with heaves or chronic, more severe IAD are often treated on a short-term basis (one to two months of a tapering dose) with a systemic corticosteroid such as dexamethasone or prednisolone and often have longer-term treatment with an inhaled steroid while environmental remediation is underway. It is important to remember that steroids take time to
work. Although there are relatively quick onset anti-inflammatory effects, steroids, in general, must work by changing the portion of the nuclear ‘code’ that is read in inflammatory cells, and that takes time.

Inhaled corticosteroids, like inhaled bronchodilators, must be used with either a spacer device or a nebulizer. We usually recommend either QVAR ™, which is a proprietary form of beclomethasone which in humans has been shown to be deposited more deeply into the lung than other forms of beclomethasone, or fluticasone, which is a very effective but often quite expensive form of steroid specific for delivery to the lung via a pMDI.

**Environment**

Equine asthma can be best thought of as analogous to occupational asthma in humans. Even humans who do not have an innate allergic response leading to asthma (allergic asthma) develop pulmonary inflammation when they are exposed to high levels of particulates, such as endotoxin, beta-glucans (portions of mold), animal dander, inorganic particulates and ammonia gases, which are all found in high concentrations in agricultural operations. The upshot is that people working on livestock farms, or in cotton factories, woodworking facilities, landscaping and, not surprisingly, equine facilities, have a high level of occupational asthma. Even the best equine barns have a high level of particulates, so it is equally unsurprising that horses, especially those living in cold climates and housed in the winter, have a high prevalence of equine asthma.

For people who live on large properties, it can be relatively easy to fix the environment for a horse with IAD or heaves. If you have space for a five to ten-acre pasture and can make a three-sided shed where the horse can get away from rain and winds, even the most delicate show horses can live happily outside in the deep winter. In our area of the world – New England – land is expensive and this is simply not an option for many people. Those in the South, on the other hand, may need to bring the horse inside during the high season to protect against pollens and molds. Increasingly in the Northeast, we also face this problem during warm, moist weather.

Even if you cannot find that beautiful 10-acre pasture with a shed for your coughing horse, there are many ways that you can improve their indoor environment. First and foremost, it is important to change the way your horse is eating because what is at his mouth is also at his nose, and that is the fast route to the lungs. So, remove the hay net and if possible, the hay. If you cannot remove the hay, make sure it is well-soaked before you feed it to your horse. If your horse depends on hay for nutrition, then you should not soak the hay for more than 20 minutes, or you will leach much of the nutrition out of it. However, if your horse is over-conditioned (in other words, fat), or if your horse is getting hay simply to stay occupied, then it may be a good thing to soak some of the sugars out. Make sure that in the summertime the hay does not rot in the water. Keep your buckets and soaking areas scrupulously clean. Denge hay can be very useful, as can hay steamers or haylage. Be aware that some of the baked/chopped hay products can be very high in molasses, which is not good for a horse with EMS.
steamers can be fire hazards if you don’t follow instructions closely, and poorly prepared haylage can lead to botulism. A complete pelleted feed has been shown in multiple studies to be the best approach to avoiding problematic dust for the horse with equine asthma. That being said, horses become bored and sad without something to munch on all day long. Think of hay as their TV, computer and crossword puzzle all rolled into one. If your horse must be on a complete pelleted feed (and some cannot manage any other way), then you’ll need to work hard at enriching the environment.

Hay can be a problem even if it is being fed to the horse in the stall next door, or if it is stored overhead or in an adjacent stall. It is healthier and safer, in terms of fire hazards, for hay to be stored in a separate building. Bedding is another culprit. Shavings produce less dust than straw, but pelleted beddings or paper bedding is better. Horses can do just fine on rubber mats if they are kept clean. Remember that when horses live outside (the most natural way for a horse to live), they sleep on the hard ground quite happily.

When dust is stirred up, it can stay in the air for hours, especially when horses are fed or stalls and aisleways are cleaned. The commonsense approach to this is to make sure that horses are outside when any cleaning or feeding is done, and that they stay outside for several hours afterwards. I have often had clients tell me that they are worried that their horses will be too cold, but horses love the cold as long as they have a good haircoat or at least a good blanket. We keep our barns warm not for our horses, but for us. I have never seen horses grow chilled as long as they can get out of the rain and the wind. They delight in a crisp snowfall, and they love a gentle rain.

Other ancillary treatments

There are many different ‘miracle’ products on the market, but few of them have actually been tested in any reputable way. One of the few things that have been shown to be a useful ancillary treatment is omega-3 fatty acids. Quickly explained, all fats are not the same, and the polyunsaturated fats can be inflammatory such as the omega-6 fatty acids or anti-inflammatory such as the omega-3 fatty acids. Some of the foods that horses commonly eat are unfortunately high in omega-6s (corn, oats, corn oil, safflower oil and sunflower oil). Old-time horsemen and women seem to have known about the benefits of omega-3s instinctively. Anyone who grew up in the 1970s or earlier can probably still remember the distinctive odor of a flaxseed mash on Sunday nights. Flaxseed is high in omega-3s, as are supplements made from salmon, herring and mackerel, canola oil or chia seeds.
Recent Publications


16. *Pacheco A, Bedenie D, Mazan MR, Hoffman AM. Respiratory mechanics and results of
cytologic examination of bronchoalveolar lavage fluid in healthy adult alpacas. Am J Vet
Res 2012;73:146-152. PMID 22204301
device to evaluate airway hyperresponsiveness in horses after chronic administration of
Mazan MR. Age effects on blood gas, spirometry, airway reactivity, and bronchoalveolar
PMID: 24528225
19. *Houtsma A, Bedenie D, Pusterla N, Pugliese B, Mapes S, Hoffman AM, Paxson J,
Rozanski E, Mukherjee J, Wigley M, Mazan MR. Association between inflammatory
airway disease of horses and exposure to respiratory viruses: A case control study.
Multidiscip Respir Med, 2015;3:10:33;3 PMID26535117
20. Mazan MR, Update on Noninfectious Inflammatory Airway Diseases of the Horse. Vet
Clin North Am Eq Prac, 2015;31:159-185 PMID 25770068
21. Viner M, Mazan MR, Bedenie D, Mapes S, Pusterla N. Comparison of Serum Amyloid A
in Horses with Infectious and Noninfectious Respiratory Disease. J Vet Eq Science,
February 2017, Vol 49, pp 11-12

Book Chapters

Based Approach. Mosby, 2006
3. Mazan MR. Equine Inflammatory Airway Disease. In: Smith B. Large Animal Internal
Medicine, 3rd edition. Mosby Harcourt, 2007
Current Therapy in Equine Medicine 7, Elsevier Health Sciences, 2007
5. Mazan MR. Managing Inflammatory Airway Disease in the Pleasure Horse. In: Robinson
NE, ed. Current Therapy in Equine Medicine, Elsevier Health Sciences, 2008
Elsevier, 2011
Horse. Elsevier, 2011
The Horse. Elsevier, 2011
The Horse. Elsevier, 2011