

Fall 2018

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A Review of Therapeutic Drugs Used for Doping of Race Horses: NSAIDs, Acepromazine, and Furosemide

Abstract

Doping in the horse racing industry has been a problem ever since it began. Different drugs are used to increase the chance of winning, losing, and even masking the use of other drugs. Some drugs are used only to enhance performance, but there are also some that are used therapeutically that have the capability to alter the performance of the horse. The three drugs that will be discussed in this review are NSAIDs, Furosemide, and Acepromazine. NSAIDs are used to control pain and inflammation, but in doing so can allow the horse to run at full capacity even if there is an underlying injury such as a sprain. Furosemide is a diuretic that therapeutically is used to decrease the chance of developing exercise-induced pulmonary hemorrhage, but can also mask the use of performance enhancing drugs. Finally, acepromazine is a sedative that can be used to calm a horse who is overly excitable but can also be used to decrease the performance of a horse in order to alter the winner and can have an impact on those that are betting. The pharmacology of these three drugs will be further explored into how they exert their effect and the potential harm they can cause.

Introduction

The horse racing industry is a billion dollar industry with more than 1.2 million horses used for racing (AHCF, 2017). In the United States, the most significant racing event is the Kentucky Derby held in Louisville, Kentucky on the first weekend of May each year.

The winnings from the race total \$2 million. On the side, there are also bets placed that can surpass \$200 million and that only includes the legal bets that were placed

throughout the day. With so much on the line, it is no surprise that drugs would be used illegally to increase the chances of a horse winning or losing (Tuttle, 2018).

The most apparent use of drugs given on race day involve those for doping to win. This method is characterized by improving the overall physiologic capacities of the horse. The drugs that are most used include NSAIDs, steroids, and bronchodilators. The other option for drug use involves doping to lose where the ability of the horse is impaired in some way. The most common drugs for this category are sedatives or tranquilizers. Another important use of drugs is known as doping to mask which involves using masking agents that will hide the use of other drugs. These drugs are diuretics such as furosemide, and this makes the use of illegal drugs harder to detect. The final classification is inadvertent doping which is characterized by being unaware of the side effects of combining drugs or supplements and how long those effects would ensue (Ungemach, 1985). However, this is a smaller category and with proper care and drug administration can be avoided. Therefore this categorization will not be examined further.

Most drugs are not allowed in any quantity on race day in order to try to combat the doping of horses. Therapeutic drug classes are a bit harder to control since they have a function that can aid in the horses' overall health. To try to control the overuse of these drugs and to



Figure 1: Justify #7 was the winner of the 144th Kentucky Derby held at Churchill Downs on May 5th, 2018 in Louisville, Kentucky. Image obtained from Forbes.

decrease the potential for doping, officials have tried to establish a policy in the United States which has legalized certain drugs and created limits on the administration of those drugs. The way in which these drugs are categorized is known as the Uniform Classification of Foreign Substances and was created by the Association of Racing Commissioners International (RCI). This group gets together to review the policies on a semi-annual basis to keep up with changing drug availability and ever growing knowledge on the drugs. There are four classes of drugs which range from Class 1 to Class 5. Class 1 drugs do not have a therapeutic use that is acceptable to the racing industry because the performance enhancing effect is extremely high. These drugs are characterized as stimulants or depressants and are typically opioids or amphetamines. Class 2 drugs are also unacceptable for therapeutic use due to their high performance enhancing ability. These drugs focus on cardiovascular and nervous system stimulants and neuromuscular blockers. Caffeine is an example of a drug from this class. The drugs that will be focused on in this review are categorized as Class 3 and Class 4 drugs. Although there is therapeutic use there is also a moderate ability for the Class 3 drugs to have the capability to enhance performance while the Class 4 drugs have a moderate to high effect. Winstrol is an example of a Class 3 drug and phenylbutazone is a Class 4 drug. The final categorization is Class 5 drugs which are allowed but have specific concentration limit requirements. There is potential to have performance enhancing capabilities but with controlled dosage this is lessened. Class 5 drugs have a localized action and an example is ranitidine (Allin, "Part 4").

In the subsequent sections several of the drugs used for doping to win, lose, and mask will be examined. The pharmacology, effects, and detrimental use of each will be assessed. The possible testing methods and the allowed concentrations of several drugs will also be explored. Finally, the concerns for the future will be addressed and will focus on the continual use and abuse effects that could potentially occur.

Doping to Win

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are possibly the most used class of medications in equine medicine for the alleviation of pain and inflammation of the musculoskeletal system (Kynch et al., 2018). Phenylbutazone is an example of an NSAID that is used to treat sprains, strains, muscular overuse, and tendonitis (Allin, "Part 7"). Being a Class 4 drug there is a beneficial therapeutic use that causes increased use of the drug. In 2010 the United States Equestrian Federation created a new rule that only allows the use of one NSAID during races. This rule came about because of a practice known as "stacking." The previous rule allowed two NSAIDs to be used as long as phenylbutazone and flunixin were not used together (Sweeney, 2010). Phenylbutazone is commonly administered intravenous but is not allowed 24 hours pre-race (Racing Medication and Testing Consortium [RMTTC], 2016). The pharmacology of how these drugs act will be explored next.

Pharmacology

There is little evidence that NSAIDs on their own lead to enhanced performance. Instead, it masks the pain and increases mobility through the inhibition of cyclooxygenase enzymes known as COX 1 and COX 2 (Kynch et al., 2018). COX 1 enzymes are expressed in most tissues (Rang et al., 2016) including the gastrointestinal tract while COX 2 enzymes are found around sites of inflammation (Hawkey, 2001). Typically after tissue injury, arachidonic acid is oxidized by these COX enzymes and leads to the production of eicosanoids, specifically prostaglandins. By inhibiting cyclooxygenase, the oxidation of arachidonic acid is prevented and leads to decreased production of eicosanoid. These inflammatory mediators include prostaglandins, leukotrienes, and thromboxane A₂. All play an essential role in the inflammatory cascade and cause increased vascular permeability, heat, and decreased nociceptor thresholds (Kynch et al., 2018).

The COX 1 enzyme is constitutional and produces prostaglandins that protect the mucosa of the stomach, aid in aggregation of platelets, and plays a role in blood flow through the kidney.

The inhibition of these actions occur quickly and are reversible. The COX 2 enzymes are inducible and produce prostaglandins that recruit inflammatory cells to sites of inflammation. COX 2 inhibition is irreversible. Many NSAIDs are non-selective and inhibit both COX 1 and COX 2 enzymes.

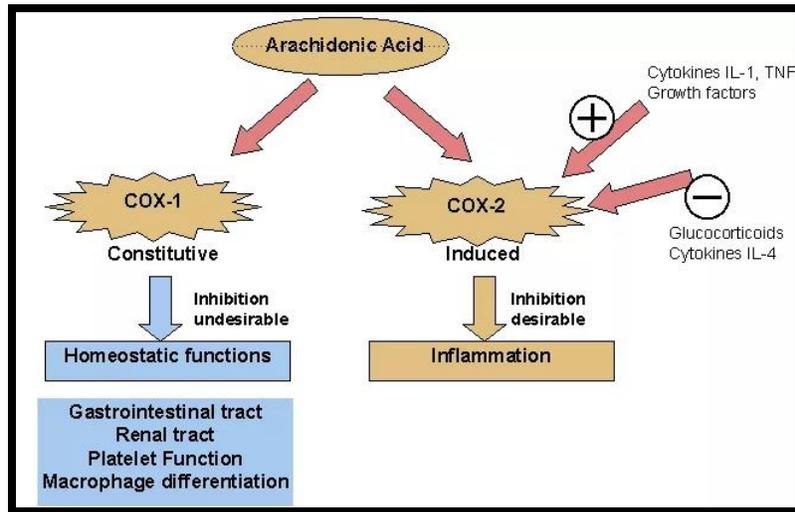


Figure 2: COX 1 and COX 2 Mechanisms of Action. Image Obtained from Hayat, 2013.

This is not always ideal as

COX 1 is responsible for homeostatic functions. Some non-selective NSAIDs that are used in equine include phenylbutazone and flunixin (Rang et al., 2016). However, some NSAIDs are selective only for COX 2 inhibition and focus solely on reducing pain and inflammation. Firocoxib and meloxicam are both examples of COX 2 selective inhibitions that are used in equine (Walden, 2017).

Detrimental Use

Short term NSAID use itself does not produce many side effects as compared to chronic use. However, a common practice that is has been known to be used in the horse racing industry is known as “stacking” NSAIDs. Stacking NSAIDs refers to the practice of administering two different drugs from the same class at the same time. The conventional NSAIDs of choice are flunixin and phenylbutazone although the use of both of these drugs at the same time is currently illegal in the horse racing industry. There is little research that provides evidence of any positive effects of combining the abilities of two NSAIDs. Some speculate that the use of two together will create an even more significant benefit than if only one was administered. There are others who believe that stacking does not produce that effect and can actually increase unwanted side effects. One study was performed that used thirteen horses split into two groups to determine the

effects of one NSAID compared to two administered at one time. The first group of horses were given phenylbutazone and flunixin together and then after some time was given only phenylbutazone while the second group had the opposite treatment. Blood samples were collected on the first and last days of administration, and the protein levels were examined. The reason protein levels were read was due to the fact that when the gastrointestinal tract is damaged protein concentrations are severely decreased. For the second group that was only given phenylbutazone first, there were insufficient changes in the protein levels but after both drugs had been administered the protein levels dropped dramatically. These results led the researchers to believe that by using more than one NSAID at a time, the gastrointestinal tract was severely damaged. There was even one horse that died from NSAID toxicity (Equus, 2006).

Not only are NSAIDs used during race time, but they are also used before when the horses are preparing for races. Another issue with continual and repeated use of NSAIDs in racehorses is that over time the horse will develop a tolerance to the drugs. The effectiveness of these drug will begin to decrease, and a larger dose will be required to obtain the same effect as was initially seen (Allin, "Part 7"). A common NSAID used is phenylbutazone which can increase the risk of gastrointestinal ulcers when administered on a continual basis or increased dose. Ulcers are a common ailment of horses, but there is an increased risk in racehorses due to the overuse, high-intensity exercising, and also stress (Allin, "Part 4").

Doping to Lose

Acepromazine is a common sedative in the horse industry used for the calming and tranquilizing effects that it produces. Many people may not think of this type of drug being used in horse racing, but it can be used to decrease the performance of a high profile horse that is pegged to do well. The appeal of this is that people will bet on the horse that is expected to do well and will lose those bets while there may be a select few who bet against that horse and then win those earnings (PubChem CID: 6077, n.d). Acepromazine, commonly referred to as Ace, is typically administered intravenous and can be detected in the serum for at least 48 hours (RMTC, 2016).

Pharmacology

Acepromazine is a phenothiazine derivative which causes antiemetic properties to be exerted on the central nervous system (PubChem CID: 6077, n.d). Although the complete mechanism of action is not well understood, because it is classed in the phenothiazine group of drugs, it is thought to affect in large part the dopaminergic receptors (Kynch et al., 2017). It is also believed to act as an antagonist on not only dopamine but also serotonin, histamine, alpha-1, alpha-2, and muscarinic receptors (PubChem CID: 6077, n.d). Phenothiazines act specifically on D2 dopaminergic receptors to act as a sedative and tranquilizer. Dopamine receptors are known as G-protein coupled receptors and act as first messengers through their interaction at postsynaptic membranes. Through these interactions transduction of G-proteins occurs at the necessary intracellular effector system (Riviere and Papich, 2009).

After intravenous injection, acepromazine is eliminated quickly due to the rapid metabolism of its metabolites, 2-(1-hydroxyethyl) promazine (HEP) and 2-(1-hydroxyethyl) promazine sulfoxide (HEPS). A study published in the Journal of Veterinary Pharmacology and Therapeutics was performed on thoroughbred horses to determine the metabolism of acepromazine intravenously. Fifteen total horses were used and for the intravenous injection two catheters were placed in the external jugular veins. One of the catheters was used for administration of the drug while the other was used for retrieval of blood samples. A blood sample was collected prior to administration of the drug. A single dose of 0.09 mg/kg of acepromazine was administered to each horse. The next sample collections began after five minutes and continued in intervals all the way up to 72 hours post injection. During analysis of the blood samples, the collection tubes sat at room temperature for at least twenty minutes and then were centrifuged to obtain a serum sample (Kynch et al, 2017).

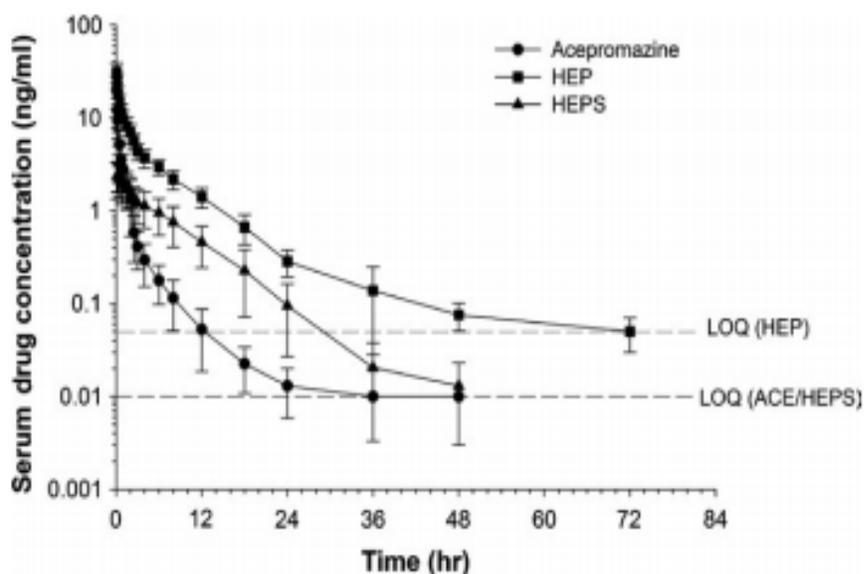


Figure 3: Concentration of acepromazine and metabolites in the serum over time. Image obtained from Kynch et al., 2017.

The serum was analyzed using a technique known as liquid chromatography-tandem mass spectrometry to determine concentrations of acepromazine, HEP, and HEPS. TSQ Vantage triple quadrupole mass spectrometry coupled with turbulent flow

chromatography was also used for quantitative analysis of the serum. 85% of acepromazine, 80% of HEP, and 100% of HEPS was recovered in the serum. The concentrations of the acepromazine and its metabolites are characterized in Figure 3 (Kynch et al, 2017).

Detrimental Use

If administered in too high of a dose, acepromazine toxicity effects can be severe. Some of these symptoms include convulsions, difficulty breathing, irregular heart rate, and low blood pressure (PubChem CID: 6077, n.d). By impacting dopamine receptors, high levels can cause extrapyramidal signs that include restlessness, rigidity, and tremors. There are also effects on the hypothalamus that alter the ability to regulate their temperature leading to a decrease in body temperature and possibly hypothermia. Acepromazine is also an alpha-1 adrenergic blocker and therefore causes vasodilation, a decrease in blood pressure, and even tachycardia if severe enough. Another cardiovascular problem that can occur is decreased hematocrit levels caused by the accumulation of red blood cells in the liver and spleen (Pawson, 2008). Interactions with other drugs can lead to some of the severe side effects and may cause prolonged central nervous system depression (Riviere and Papich, 2009).

Doping to Mask

Furosemide is a common Loop diuretic that is responsible for increasing urine output. This drug has a fast onset and short duration of action. From these actions, it is important in horse racing because it allows for a decreased chance of detecting other drugs that may be in the horse's system because it does increase urine output thus increasing the excretion of other drugs that were administered to the horse (Hinchcliff and Muir, 1991). Some drugs that furosemide masks include corticosteroids, NSAIDs, albuterol, and opioids. Since furosemide acts by increasing the output of urine, any drug that is primarily excreted in the urine can be masked (ARCI, 2017).

The therapeutic use of furosemide and the reason it is allowed to be administered four hours before race time is for decreasing the risk of exercise-induced pulmonary hemorrhage although the mechanism for this is unknown (Hinchcliff and Muir, 1991). Exercise-induced pulmonary hemorrhage causes bleeding in the lungs and nasal canal during high-intensity exercise. (Gershman, 2018). When horses run at high intensities the volume and pressure of blood and air increases dramatically during inspiration and expiration and can cause the blood-gas barrier of the alveolus to rupture. This results in blood entering the lungs and is thought to occur in at least a small degree in most racehorses. Repeated bleeding in the lungs causes permanent damage and can in some cases be fatal. The use of furosemide is thought to decrease the number of incidences by decreasing fluid buildup, increasing urine production, and decreasing hydrostatic pressure. The increase in urine output can also allow the horse to lose quite a bit of weight making it ideal for racing (Hickok, 2018).

Pharmacology

What is known about the mechanism of action of furosemide is that it has a direct action on renal tubular function through the inhibition of sodium and chloride reabsorption in the ascending limb of the Loop of Henle. Inhibition of both sodium and chloride is controlled at the Na:K:Cl cotransporter found on the luminal surface. By binding and inhibiting at the chloride site on the cotransporter, there is an increase of sodium and chloride delivery to the distal tubule. This leads to an increase in the production of a large amount of isotonic urine, otherwise known as when the urine has equal osmotic concentrations. Aspects that can alter the diuretic response

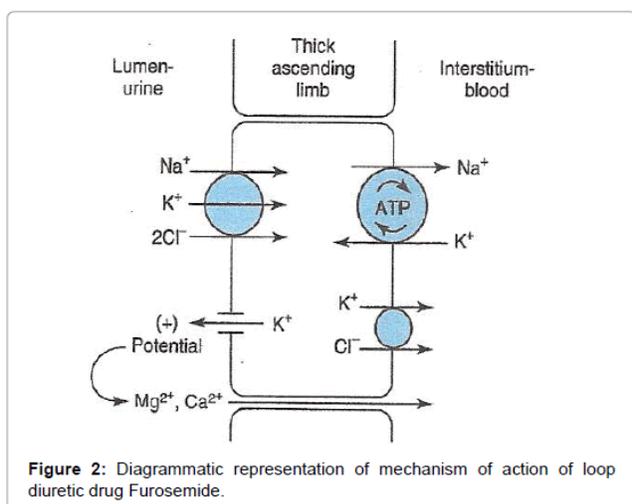


Figure 4: Mechanism of Action of Furosemide.
Image Obtained from Saad, 2017.

includes changes in the plasma protein binding, renal blood flow, and plasma furosemide concentration (Hinchcliff and Muir, 1991). When the transport of sodium from the lumen of the Loop of Henle to the basolateral interstitium is inhibited, the lumen becomes more hypertonic and the interstitium less hypertonic. These effects significantly reduce the osmotic gradient that allows for water reabsorption in the nephron (PubChem CID: 3440, n.d).

Although the exact mechanism of action is unknown, it is believed that furosemide prevents exercise induced pulmonary hemorrhage through several actions. It functions by increasing the rate of urinary sodium, chloride, and hydrogen ion excretion, and decreases potassium plasma concentrations. Renal blood flow and venous compliance are increased while right atrial pressure, pulmonary artery pressure, pulmonary artery wedge pressure, and pulmonary blood volume decrease. Effects of furosemide are modified by administration of NSAIDs before furosemide administration. Furosemide reduces the exercise-induced increases in right atrial, aortic and pulmonary artery pressures (Hinchcliff and Muir, 1991). Since furosemide is a potent diuretic, it only takes about four hours to move through the system which is a quick metabolism compared to most other drugs (RMTC, 2016)

Detrimental Use

Although therapeutic use of furosemide is used to aid in the overall wellbeing of the horse, it can also have some unwanted side effects. The diuretic effects can lead to dehydration, blood volume reduction, and loss of electrolytes. (PubChem CID: 3440, n.d). These symptoms can leave the horse susceptible to muscle weakness and failure which in turn can lead the horse to collapse. Collapse can lead to other injuries which can lead to death in a horse (Hickok, 2018). The overuse of furosemide has mild effects such as nausea, vomiting, and diarrhea, but more severe effects can come from taking other drugs along with furosemide (PubChem CID: 3440, n.d). In order to combat the detrimental effects of furosemide, it has been proposed that we focus on genetics to remove the trait for bleeding from the gene pool. Nasal strips have also been examined as another option for replacement of furosemide use (Hickok, 2018).

Testing

Several different testing techniques are available in the United States. There is currently no standard of testing in the horse racing industry, so many of these techniques are performed based on what drugs are being tested for as well as the availability of equipment in the area of the races. Below are two techniques that are the most commonly used based on efficiency, accessibility, and time.

Liquid chromatography-tandem mass spectrometry (LC-MS-MS) can test for nineteen different drug classes using equine plasma. This process uses on-line solid-phase extraction (SPE) along with triple quadrupole mass spectrometry. After the plasma is obtained from the horses, the samples are protein precipitated using acetonitrile. The supernatant formed after centrifugation is then injected into the on-line SPE system and analyzed through the triple quadrupole LC-MS-MS. This technique allows for a short turn-around at less than ten minutes. Of the nineteen identifiable drugs bronchodilators, corticosteroids, and sedatives are able to be detected to parts per billion (ppb) level. Due to the time, efficiency, and availability this test is performed fairly regularly with equine plasma for pre-race screenings (Kwok et al., 2010)

Another technique for testing for drugs in racehorses is the non-isotopic immunoassay which utilizes the particle concentration fluorescence immunoassay (PCFIA) and the enzyme-

linked immunosorbent assay (ELISA). These tests are fast, inexpensive, and effective. When ELISA testing was first performed, several drugs were detected that had previously gone undetected. Unlike the thin layer chromatography based testing, the ELISA testing did not have a substantial rate of false negative results. A couple of medications that are individually tested for include acepromazine, phenylbutazone, and furosemide. The non-isotopic immunoassays can test the most potent of drugs, is adaptable to which drugs are being tested, and can be performed before and after racing. Both of these tests are also available to test the jockeys and other personnel on the racetrack (Tobin et al., 1988).

There are other tests available besides the two listed above. These can include tests that use urine, plasma, serum, saliva, or hair for detection and analysis of drugs. Although the time, efficiency, and availability are the main reasons these two tests are used most often, it is also possible to choose a test based on which drugs are being screened. It may also depend on whether the samples will be collected pre-race or post-race (Tobin et al., 1988).

In regards to the concentrations of drugs allowed in the serum or plasma this depends on the drug itself. According to the Reformed Racing Medication Rules provided by The Jockey Club “no horse participating in a race shall carry in its body any medications, analogues, or metabolites thereof except as provided”. Several NSAIDs listed include phenylbutazone, flunixin, ketoprofen, and methocarbamol. Those concentrations that are allowed per one milliliter of serum or plasma are as follows: one microgram of phenylbutazone, five nanograms of flunixin, one nanogram of ketoprofen, and one nanogram of methocarbamol.

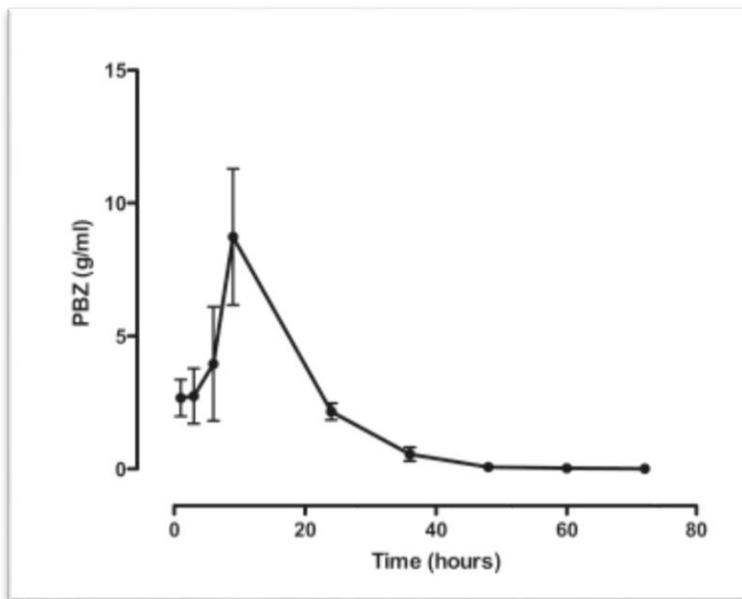


Figure 5: Phenylbutazone withdrawal period. Image obtained from Meucci et al, 2015.

These concentrations are during blood collection post-race. Phenylbutazone, flunixin, and ketoprofen are also not allowed to be administered within 48 hours of the post-race time.

Some drugs including butorphanol, firocoxib, and lidocaine are allowed if an exemption form is on file. Normally firocoxib is not to be administered any earlier than fourteen days prior to post-race. For acepromazine and its metabolites post-race concentrations may not exceed ten nanograms of drug per milliliter of serum or plasma. Acepromazine is not to be administered four days prior to post-race time. Furosemide has several guidelines for its use. Administration has to be four hours prior to post-race and can be no less than 150 milligrams and no greater than 500 milligrams intravenously. Blood samples collected from the horses will be ran through any of the tests examined previously (The Jockey Club, 2012).

Concerns for the Future

All three drug classes have a therapeutic use which makes it difficult to distinguish whether they are being administered reliably or not. A concern is that if the horse owners and trainers advocate for complete freedom in use of these drugs, the ability to abuse them will increase tremendously which in turn allows for an increase in doping. With the increased use of these drugs, other drugs are also able to be increased in usage. Furosemides is currently only able to be administered four hours prior to a race, but if this was to change in order to ensure a decreased risk of exercise induced pulmonary hemorrhage other drugs would be able to be administered closer to race time and could increase or decrease the performance of the horse depending on which result is ideal for that owner. The new policy on NSAID "stacking" has prevented the use of two NSAIDs at one time, but if this policy was to be overruled, there could either be an enhanced performance for the horse or could result in severe health complications.

An additional problem with the doping of racehorses is that the public is being deceived on which horses are likely to win and those that place bets could lose confidence that they can make a fair bet. Placing bets can be for the enjoyment of those participating, but it can also be a dangerous business matter for others. If those people are being deceived, they could take their business elsewhere, or violence could occur. Neither of these options is ideal for those that are

responsible for holding the races. These circumstances might be the primary propulsion for officials creating and enforcing the policies on drug administration.

Novel medications will also begin to become a problem as there will not be enough research available to determine the usage and administration as it pertains to horses that will be in races. These new drugs will be able to slide through the cracks and make their way onto the track. For instance, there is a new NSAID known as Grapiprant approved for use in horses that could replace the typical NSAIDs and although it has been shown to have lasting effects in the blood, it has not been shown to enhance performance in horses as of yet. The details of results from one of those studies are provided below.

NSAIDs are typically used to mask the pain and inflammation associated with lameness in performance horses. However, the use of cyclooxygenase enzyme inhibitors can have long-term effects that adversely affect the body. Grapiprant is a newly approved medication in dogs that is a non-cyclooxygenase inhibiting NSAID which has shown to be effective and safe to use in veterinary medicine. Grapiprant's brand name of Galliprant and is classified as a prostaglandin E2 receptor antagonist. Grapiprant functions by binding to EP4 receptors and blocking PGE2 mediated sensitizations of sensory neurons and stimulation of inflammation. Since cyclooxygenase is not inhibited, it is thought that homeostatic functions should not be impacted. The inhibition of the homeostatic functions which are associated with many of the side effects experienced from NSAID use.

To determine if the use of Grapiprant is safe and effective in horses, a study was conducted using twelve healthy thoroughbred research horses. Both mares and geldings were used between the age of two and six years old. The horses were exercised five days a week before the study and throughout the duration excluding days where the drug was administered. In order to ensure that there was no interference with other medications, the horses were not given anything four weeks before the start of the study. On the day of drug administration, the horses fasted for twelve hours before and four hours after drug administration. Every morning before administration horses was weighed and a 14-gauge catheter was placed in the external jugular for sample collection. Then a single oral delivery of 2 mg/kg tablets was suspended in water and delivered using a dosing syringe. Both blood and urine samples were obtained for a period that spanned 96 hours. Traces of the drug lasted in the serum for 72 hours while they lasted 96 hours

in the urine. Overall the drug was well tolerated in horses and will be a good candidate for further exploration and usage in the horse (Kynch et al., 2010).

Opinion

Therapeutic drugs have a distinct advantage to their use that does not have to do with doping. However, for this review, the two have a strong correlation that cannot be overlooked. Certain standards have been put in place to try and control the use of therapeutic drugs so that they are still able to exert their intended effect while decreasing the chance that they can be used for performance altering. Over the last several years testing has become more accessible and efficient allowing for results quickly after collection. This dramatically reduces the ability to use drugs for doping. However without standardized systems put in place for how testing should be conducted it is difficult to know which tests are being used and which drugs are not being tested for.

Another point is that some of the drugs listed as performance-enhancing do not enhance the performance but allow for the horse to run to their full capacity. On the standpoint of doping to win, the drugs are not increasing performance per se. However, a different issue would be that they do hide other ailments that might not allow the horse to perform adequately or could further injure the horse which would fall under an animal welfare issue. Many owners and trainers are going to want to put the race earnings before the welfare of the horse. This is why veterinarians are needed to provide protection and morality in making sure that these horses are not subjected to the administration of medications on the sole basis of winning.

Conclusion

The sport of horse racing is a massive industry that impacts millions of people. With prize money and bets being placed there is a lot at stake for performing to the maximum capacity. Although there are quite a few precautions such as testing and penalties that have been created to try to combat doping of horses, there are unfortunately still ways that this can occur. Many of the drugs that would typically be used for doping do not have any other obvious uses,

but some drugs have therapeutic uses. This can cause debate within the horse racing industry on whether these drugs should be allowed at any capacity. Currently, concentrations of different drugs in a horse's system is very limited and should not exceed the concentrations set by The Jockey Club (The Jockey Club, 2012). Without consistency in testing and restrictions worldwide, it is going to be difficult to control the use of drugs during races completely.

NSAIDs, furosemide, and acepromazine all have therapeutic uses outside of the racing industry which makes it difficult to have a strict ban on the use of these drugs based on the welfare of the animal. NSAIDs reduce pain and inflammation which leads to an increase in the mobility of the horse. Furosemide is used to decrease the risk of exercise induced pulmonary hemorrhage which can lead to severe damage to the lungs and even death. Finally, acepromazine can cause a stressed and anxious animal to be more relaxed and reduce the amount of cortisol in their system. If there were other options made available to replace the use of these drugs or restrictions on when an animal is allowed to race it may be easier to exclude all of these drugs from competitions, but there are not practices currently in place to replace any of these drugs. There are some options available, but many owners and trainers are not willing to replace drugs with other forms of treatment that would not have a simple fix to it.

Overall the regulations surrounding horse racing is few and far between. Until there is a real concern for the use of the drugs in the public viewpoint, there is unlikely to be any change. The public is contributing to the business aspect of horse racing by buying tickets, souvenirs, and placing bets both legal and illegal. As long as the cash flow is still coming in and the horse injury and death rate do not climb, change is not likely to occur.

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