The study of equine sleep and its effects on a horse's behavior have been furthered in recent years through tests and techniques, which allow research to be conducted on many species – the horse included. This article reviews various equine sleep patterns and stages of sleep in the horse. Several factors influence equine sleep, such as feeding, fasting, type of stall, and deprivation of external stimuli to name a few. In addition, sleep patterns differ from species to species depending on many circumstances including age, social grouping, feeding program, confinement, and weather among others. Sleep patterns can be altered, however, by changing some management and care practices to eliminate possible sleep deprivation.

A REVIEW

Sleep Patterns in the Horse

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Introduction

In the past 15 years, considerable interest has been shown in the entity of sleep and its effect on the behavior of the horse, or, the behavior of the horse and its effect upon sleep. Further, the electroencephalogram, electromyogram, and electrooculogram have allowed research to be conducted on the sleep patterns of many species, including the horse. Several factors influence sleep, such as feeding, fasting, type of stall, pasture, pen, or corral confinement, familiarity with surroundings, and deprivation of external stimuli to name but a few that will be reviewed here.

Equine Sleep Study History and Terminology

"Although much is known about sleep and although different species have been studied in great detail, this behavior still defies definition. No satisfactory explanation for the necessity of sleep has been offered, and no definite function has been assigned to it."[1]

While this quote may read as a harsh statement, it perhaps sums up sleep research quite succinctly. Much is known about sleep patterns but little is known as to why they differ. Therefore, the analysis of results of sleep studies often leads to speculation which is, one would hope, tempered with a great deal of scholastic judgment and common sense.

The first equine sleep studies were successfully conducted in 1963, when the sleep patterns of donkeys were explored.[2] This work was followed in 1970, by the first studies specifically devoted to the horse.[3] It was only recently that sleep was studied as a behavioral entity.[1]

The sleep patterns of the equine species differ depending on many circumstances:

- type of confinement,[4-6]
- age,[7]
- social grouping,[6,8]

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- feeding program,[7,8]
- absence of stimuli,[7,10]
- familiarity with surroundings,[3,7]
- degree of wildness or tameness,[11]
- whether the animal is a pony, horse, or donkey,[11-13]
- time of day or night,[14] and
- weather.[7,14]

Before proceeding any further, it is necessary to define some of the terms that are used by sleep investigators, as they apply to observations made in these studies.[7-10,12]

WAKEFULNESS

Wakefulness (AW) is the period during which the horse is fully awake and aware of everything that is taking place around him. The time is consumed by activities such as eating, avoiding predators, playing, or responding to the bidding of the trainer or owner.

TOTAL SLEEP TIME

Total sleep time (TST) is that portion of a 24-hour day that is spent in sleeping. It is composed of both the Slow Wave Sleep (SWS) and Paradoxical Sleep (PS) experienced by the horse.

SWS is the period in which the EEG demonstrates patterns of sleeping. During SWS, the monitored brain waves are usually slow and regular (high voltage-low activity), which is an indication that the brain is not functioning at an active level. SWS has been termed the sleep of the brain, and it is shallow in level of sleep. SWS may be accomplished both standing and in the sternal recumbent position. There is usually muscular activity but little eye movement and the eyelids may be partly open.

PS is the period in which the animal assumes lateral recumbency and experiences complete muscle relaxation with eye movement and closed lids. During this time, active irregular brain waves (low voltage-high activity), similar to those of the waking state, are observed. This stage is also referred to as the Rapid Eye Movement (REM) stage in quick sleep and is considered the sleep of the body. In humans, it is during this stage that dreaming occurs.

POSITIONAL ATTITUDES

Positional attitudes occur in the horse during sleep. These are of clinical significance, and include standing, sternal recumbency, and lateral recumbency. In the case of the recumbent positions, these attitudes may occur on either the right or the left side.

In addition to the positional attitudes of standing and recumbency, there are other observations that are worth noting. When a horse is drowsing, the head is down, the eyes partly closed, and the lower lip relaxed. Also, one hind leg is usually flexed.[1] The flexion of one of the hind legs allows for engagement of the stay apparatus of the hind leg, which helps to conserve energy.[15-17]

When a horse lies in lateral recumbency, the upper front leg is extended in front of the lower front leg and the lower leg is often flexed at both the knee and the pastern.[7,18]

Positional attitudes are important since the horse will suffer from pulmonary stasis when placed on its back. This must be considered by the surgeon when the horse is positioned in such a manner.[19] It is also noted that when a horse rolls from one side to another, there is usually a pause in the roll when the animal is at the peak of dorsal recumbency. This is necessary for the abdominal viscera to reposition themselves. If the roll over is completed rapidly, there is a good possibility for a gut twist to occur.

The Stages of Sleep in the Horse

Usually a horse falls asleep while standing and is in a drowsing state. The lids are partially open and the head hangs at a medium level. The head gradually goes down as the horse slips into SWS, and when the animal is confident about its environment, it assumes a recumbent position. The horse appears to awaken and flex the front legs, then the hind legs before going down into sternal recumbency. The animal then goes back into SWS followed by lateral recumbency and the ensuing PS.[1]

Sleep in the adult horse occurs in cycles or episodes rather than one continuous interval, as it does in humans, although both are considered diurnal species. The sleep cycle is short in nature with a short (5 minutes) SWS followed by a 5-minute PS and then another 5-minute SWS.[7] The horse usually wakes up for about 45 minutes and then goes through another sleep cycle. The TST is only about 2½[18] to 3 to 5 hours[20] per night.

TIME OF SLEEP

It has been reported that adult horses sleep only at night,[7] and that stabled horses usually do most of their sleeping at night between midnight and 2:00 a.m.[1] It has also been noted that horses sleep from 8:00 p.m. to 5:00 a.m., with the maximum concentration of SWS and PS occurring from midnight to 4:00 a.m.[11] However, if lateral recumbency is an

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indication of sleep, then sleeping occurs during the daylight hours on many occasions.[21]

DROWSINESS

Drowsiness seems to occur approximately 8% of the time a horse is resting indoors, and 13 to 14% of the time when it is resting outdoors. Horses on pasture do SWS and PS less and have more drowsiness related to survival or predation factors.[9]

The duration of sleep cycles is reported to be 15 minutes, divided into 6.4-minute SWS and 4.2-minute PS intervals.[1] The difference in time is attributed to the drowsiness stage and the presence of an intermediate state between the SWS and the PS. A partial awakening period is also recognized before going into PS and it is thought that this is a safety factor that allows the horse to make one final assessment of its surroundings before going off into deep PS.

It is believed that the mature horse cannot lie in full lateral recumbency because of its weight and the respiratory embarrassment that occurs when in that position for periods of 15 minutes or longer. This, however, is not true for foals and younger horses.[19]

NUMBER AND TYPE OF EPISODES

TST of 3 to 5 hours per day is considered 15% of the total time budget. There are 5 to 7 episodes, each of which is about 30 to 40 minutes long.[1] The PS represents about 45 minutes of time, which places the PS/TST ratio at approximately 25%. PS/TST is influenced by age. Camargue horses, however, spend no more than 5% of their time in recumbency; 2% of which occurs during the day and 10% at night.[14,22]

When horses are loose in a pasture, there may be SWS while the horse is still standing, which is allowed by the stay apparatus.[7] Horses also drowse at this time. While horses exhibit SWS in the sternal recumbency, they must be in lateral recumbency in order for PS to occur.[12]

A horse that experienced sleep deprivation showed an increase in PS when it was finally allowed to rest.[10] This is notable because horses in a tie-stall tied so short that they cannot lie down, or cross-tied in a box stall, could not rest properly and suffered from sleep deprivation.[7,9] This also occurred in the case of a horse that was confined to a sling for a long period of time.[7,23] It is appreciated that sleep deprivation precipitated abnormal behavior patterns.[7]

Most animals sleep according to the circadian cycle and there are other functions such as hormone levels, enzyme levels, digestive rate, white blood cell numbers, and body temperature that follow the same circadian cycle.[24,25] Sleep provides for both biological and physiological restoration.[7] Increases in growth hormone levels and cell division are also associated with sleep.

FAMILIARITY WITH SURROUNDINGS

Familiarity with the surroundings goes hand in hand with the survival factor of the horse since the horse is a prey animal rather than a predator.[7,26] Exposed prey animals sleep less than predators; burrowing prey animals sleep longer than exposed prey animals.

The horse must be familiar with its surroundings in order to feel secure and become willing to indulge in sleep.[7,12] In one study, any time a pony was moved to a new barn or pasture, a day or two would follow during which the animal would not sleep well and resulted in sleep deprivation.[27] If, however, there was a horse nearby that was familiar with the surroundings and it did lie down and sleep, the others soon did the same.[7] It was observed that the first animal to lie down was usually the dominant one of the group.[7,35]

When horses are on pasture there is less SWS and PS and more drowsiness — another factor related to the predator concept.[7] PS of any length is actually contrary to the survival of animals on pasture. When the animal is stabled, the reverse is true. Two reasons account for this: security within the stall, once the horse is familiar with it, and hand feeding, which prevents the animal from having to forage for itself and increases activity.

SENTRIES

Many of the studies reviewed for this article differed in their opinion of whether or not a social group of horses made use of a sentry or guard as did other species of animals and birds during periods of sleep. One group reported that when there were four to six horses in a pasture, they would usually lie down at the same time without a sentry.[21] Another research team observed that large groups of horses often had a sentry standing while the others were in recumbency.[10] Still another study used an example of a large herd of Appaloosas that all lied down at the same time, without the presence of a sentry.[28] In a study of the nocturnal activity of feral ponies, it was noted that the ponies were never all down at the same time.[11] The action of a sentry was not recognized as a dominance factor[4] and changes in sentry did not go smoothly.[29] It was also observed that one sentry did not lie down until another had been up for at least 5 minutes.[5]

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SIZE AND SHAPE OF PEN

Size and shape of pen are important factors in the manner in which equine yearlings sleep.[5,6] Large pens are associated with the greatest percentage of recumbent episodes spent with some lateral recumbency. Because of their length, large pens provide the greatest linear separation for a horse from the rest of a group.

Pen overcrowding is also a factor in sleep patterns.[5,6,] The number of episodes of recumbency and the duration of each episode is greater in each instance when comparing the recumbency occurring in large pens with small pens when each contains the same number of yearlings.

Similar results occur when a single horse trailer is compared with a group pen in that there are more recumbency episodes of longer duration when a single individual is in a box when compared with a group in a pen. Also, there are more episodes for a single horse in a pen than for a single horse in a box stall, but the duration of each episode is less and the total time is less. This is probably related to the relative peace and quiet of the box as compared with the activity in the adjoining pens.[5,6]

The grouping, herd, or social effect on recumbency time is apparent in that the duration of recumbency intervals is longer when the horses are in a group than when they are alone on the same environment.[5,6] It is interesting to note that a herd of horses often responds as though it is in an intangible enclosure.[4]

SLEEP PATTERNS OF FOALS

In the foal, sleep time occupies one-half of the daylight time at birth and then drops to the adult level of sleep by the time the foal reaches 7 months of age.[7] Other studies conclude that foals lie down 15% of the time after birth and only 2% of the time after weaning, and that newborn foals spend about a third of their time in recumbent rest,[14] indicating that sleep is very important to the young.[7,13,31] It is believed that the large amount of time the foal spends in recumbency is necessary for the assimilation of information obtained during waking periods into a long-term memory trace.[32]

One observation of the newborn foal revealed that once a foal is up and nursing, attempts to lie down are apparent in the second hour after birth.[29,33] After nursing, the onset of recumbency ranges from 90 to 217 minutes with an average of 153 minutes. Drowsiness and sleep occur an average of 174 minutes after birth. Standing foals were observed to lower their head and rest an average of 85 minutes. The average duration of rest periods is 7 minutes and whenever the foal goes down it is usually within 1 meter of the dam.

OTHER FACTORS AND OBSERVATIONS

Peace and quiet also plays an important role in a horse's bid for a restful sleep. In the absence of sight and auditory stimuli there is an increase in the SWS and a large increase in the PS.[7,10]

Feed contributes to the sleep pattern, as well. There is an increase in the sleep episodes of the horse when the diet is changed from that of hay to concentrates. If a horse is fasting, there is even more evidence of increased sleep.[9]

Donkeys apparently spend more time in recumbency than horses, with about 31% of their time spent in recumbency and less than 5% of that in lateral recumbency.[2] Horses resemble the dog, cat, and humans in their sleep patterns in that they are all diurnal individuals. There is, however, a wide divergence from the pattern of the bovine.[30] When horses are compared with bovines, it is revealed that horses spend 81% of their day in alert wakefulness and 8% of their day in drowsiness, whereas cattle spend 52% of the day in alert wakefulness and 31% of the time in drowsiness.

An interesting study performed with other species demonstrated that there is a humeral effect of sleep inducement. When the CSF is taken from a sleep deprived goat and injected into another animal sleep was induced in the recipient.[34]

Only one pathological condition has been reported – narcolepsy – which was observed in both dogs[35] and horses.[1,4,20,35-39] These reports describe classic signs of narcolepsy as it appeared in humans. Further, there was a positive response to the same therapeutic regimes that have been successful in humans.

TRAVEL PROBLEMS

Sleep deprivation because of unfamiliar surroundings is a serious problem. This can occur especially when horses are being shipped for shows, races, or breeding.

When mares and foals travel a long distance, provisions must be made to allow the foal to lie down.[31] Foals require a large amount of time for PS, and lack of adequate rest could equate to a stress factor that would compromise the health of the foal and precipitate an illness. It could also disrupt the normal learning patterns and resulting physiological trauma could manifest itself later as fear of trailers and enclosed spaces.

To help remedy problems encountered while traveling, one solution is to place the transported

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horse in an oversized stall at its destination. This allows for constant attendance by a familiar groom, including having the groom in attendance 24 hours a day.

Perhaps the concept of a companion goat, chicken, goose, or other animal is a very meaningful method of providing additional familiarity for the horse during its travels. This may be particularly true if the horse is expected to perform within a day or two of arrival at the new destination.

An alternative is to either ship a horse at least a week before an anticipated event or the day before or the day of the event. Shipping in 3 to 4 days before an event may not be enough time for recovery from sleep deprivation to occur. Further, since most receiving barns have solid stall partitions, the horses cannot see one another, thus reducing or absenting the benefits that can be derived from visual and vocal socialization.

The persons involved in the management of performance horses should be acutely aware of the temperamental makeup of the horse since some horses require more time for familiarization and recovery from the sleep deprivation induced by shipping than others. Each horse must be appraised separately.

An interesting ongoing study by workers at the Irish Equine Research Institute examines blood samples from horses taken before and after shipping.[18,40] Many of these horses are involved in transcontinental shipments. The analyses show changes in the blood parameters from before shipping to after. The study has not yet concluded whether these changes in blood parameters result from the stress of travel per se or from sleep deprivation due to changes in familiar surroundings.

This could be evaluated easily by doing the same blood analyses on mares that are moved but a short distance for breeding so that the stress of a long distance move would not be a factor of a shipping stress, and yet, the stress of sleep deprivation should be apparent since these horses do experience changes in environment.

It would also be interesting to do some hormonal assays of estrous mares, at night, during the periods of deep sleep and compare them with the daylight non-sleeping periods. This should be done on the resident mares as well as the transient mares shipped in to be bred. It is possible that some of the anovulatory cycles of mares are related to stress associated with sleep deprivation that could result from translocation, strange surroundings, and/or changes in personnel and feeding practices associated with the movement of mares during the breeding season.

Since most deep sleep occurs in the horse at night and since it is known that most ovulations in mares occur during the night, there may be some correlation between sleep deprivation and anovulation or even reduced fertility for a short period of time.

FURTHER CONSIDERATIONS

It is evident that the horse can sleep while standing in sternal recumbency and lateral recumbency, but the level of sleep depending upon the position will vary in depth and the mental and physical benefits so derived are not the same.

A horse will usually lie down about the same time each day. If a horse lies down at a time other than the usual time, it is probably due to one of four reasons:

- the horse is very sick;
- the horse is having trouble with colic;
- the horse is very leg or foot sore; or
- the horse is physically exhausted.

Conclusion

The sleep patterns of the young and the mature horses studied, demonstrate that the horse is a polyphasic sleeper that can sleep both standing and lying down. The most beneficial and necessary sleep is sleep that is achieved during the short sleep periods in lateral recumbency. Sleep patterns can be altered by changing the feeding practices, shipping and placement in a new barn or pasture, overcrowding, and size and shape of the confining pens. Any management factor that induces sleep deprivation should be corrected. The importance of sleep deprivation cannot be overemphasized. ■

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ADDITIONAL READINGS

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