

# Sleep and Sleep Disorders in Horses

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Sleep in the horse is essential for its overall health. Sleep disorders and lack of sleep can seriously compromise horses' physical activity and even worse, quality of life. Limited information and lack of understanding of sleep and associated disorders may lead to inaccurate diagnosis and management. Authors' addresses: Department of Medicine and Epidemiology, Tupper Hall 2108, One Shields Avenue, School of Veterinary Medicine, University of California at Davis, CA 95616 (Aleman); The William R. Pritchard Veterinary Medical Teaching Hospital, One Shields Avenue, School of Veterinary Medicine, University of California at Davis, Davis, CA 95616 (Williams); and Department of Surgical and Radiological Sciences, One Shields Avenue, School of Veterinary Medicine, University of California at Davis, CA 95616 (Holliday); e-mail: mraleman@ucdavis.edu (Aleman). © 2008 AAEP.

## 1. Introduction

Sleep is important to our health; the same is true for horses. However, horses require far less sleep than most humans, averaging a total of only 3–5 h/day.<sup>1</sup> Foals, especially neonatal foals, sleep more per day than adult horses. Their periods of sleep are more numerous, longer, and more frequent than those of adult horses. Horses are neither diurnal nor nocturnal but have intermittent periods of rest and sleep during the day with most of their sleep happening at night, particularly when confined in a stall.<sup>2</sup> Certain relaxing situations, such as grooming or standing quietly in crossties, may even lead to episodes of sleep in normal horses. This is, perhaps, the equine equivalent of sleeping in class. The exact details of equine sleep are poorly understood, because many studies have relied solely on behavioral observations.<sup>3–5</sup> Far more data exists on human sleep, and yet, the physiologic need for sleep remains a mystery. Literature about sleep in

the horse is profoundly limited; furthermore, sleep disorders are even less understood, which may result in controversy and sometimes, misdiagnosis and inaccurate management. In addition, sleep disorders or simply a lack of sleep may seriously impair a horse's physical activity and quality of life. Sound sleep is essential for the overall health of our equine companions and should be taken more seriously. Therefore, the purpose of this review is to give a brief overview of human sleep to lead into the discussion of sleep in the horse and also, to discuss a few of the recognized but still poorly understood sleep disorders in the horse.

## 2. Materials and Methods

A brief overview of human sleep and sleep stages will be described followed by an overview of sleep and sleep disorders in the horse based on the limited information available and current studies from the authors.

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## NOTES

### 3. Results

#### Overview of Human Sleep

Observation of sleep has been essential to understand the details of sleep; however, sleep staging in association to sleep behavior has only been possible with the use of electrodiagnostics. Sleep staging is based on specific features recorded in the electroencephalogram (EEG), electrooculogram (EOG), and electromyogram (EMG). The electrocardiogram (ECG) and respiratory patterns are also recorded and may influence the scoring in some cases. Collectively, this data and the science of interpreting it is known as polysomnography.<sup>6</sup> Sleep in humans is classified in stages: wake stage, stage 1 (drowsiness), stage 2 (light sleep), stages 3 and 4 (slow wave sleep [SWS] or delta sleep), and stage REM (rapid eye movement). Stage non-REM (NREM) is a term used collectively for stages 1–4 of sleep. Each stage of sleep is characterized by specific EEG events (voltage and amplitude). Knowledge of the interpretation of EEG events is essential, because benign variants could easily be mistaken for epileptiform activities such as those observed during drowsiness. These benign variants are even more pronounced in patients that have undergone a period of sleep deprivation.<sup>7</sup> REM is characterized by lack of tonic EMG activity and episodic REMs. Most dreaming occurs during this stage. REM sleep is usually ~25% of the total sleep time (2 of 8 h). The term sleep cycle is used to describe a complete set of NREM and REM sleep. Individuals initially go through all the stages sequentially from wakefulness to SWS (wakefulness to drowsiness to light sleep to SWS) followed by light sleep before the first REM sleep occurs. The first NREM sleep period lasts an average of 90 min before the onset of REM sleep. As the evening progresses, NREM episodes are shorter, and REM ones are longer. Also, they are no longer sequential, because very little deep sleep (SWS) occurs after the first cycle. Most people average four to five cycles over the course of one night's sleep.

#### Sleep in the Horse

Various factors such as difficulty in studying the behavior of sleep along with EEG, lack of telemetric EEG units that would record from a distance so as not to interfere with the horses' natural activities, and maintenance of EEG electrodes for long periods of time in a natural setting limit sleep studies in the horse. As a result, very little information is available on natural sleep in the horse. There are few "in-doors" sleep studies (Fig. 1).<sup>8</sup> Our studies included adapting horses for a period of 1 wk to stall confinement before EEG sleep study. Horses were clinically and neurologically normal. Personnel and equipment were isolated from horses. A cable installed across the stall allowed the electrode input box to be suspended on a movable wheel, which enabled the horse under study to move freely in the



Fig. 1. Twenty-four-hour EEG and video monitoring system at the Veterinary Medical Teaching Hospital at the University of California at Davis. Note the EEG electrodes in the horse's head. The horse is still free to move around the stall.

stall. Surface electrodes were held in place with collodion according to a standard University of California at Davis protocol.<sup>8</sup> Needle electrodes were used to record EMG and ECG activities. Respiration was monitored with a respiratory sensor. A total of 16 electrodes including the ground electrode were placed subcutaneously over the scalp of the horse to cover occipital, parietal, central, frontal, and frontal polar areas. Sedation was not used for patient preparation and electrode placement. All EEGs were recorded on a digital system equipped with synchronized video monitoring.<sup>8</sup>

Sleep staging in horses is not nearly as sophisticated as it is in humans. Muscle and movement artifacts obscure the EEG in horses that are fully alert. Another problem is that the horse lacks a true alpha rhythm, although some of the background activity does fall in the alpha-frequency range. This makes the transition from wakefulness to drowsiness difficult to identify with EEG alone. In the equine literature, the terms relaxed wakefulness,<sup>9</sup> diffuse wakefulness,<sup>10</sup> drowsiness,<sup>8</sup> and somnolence<sup>11</sup> have all been used to describe this vague state of vigilance. The presence of intermittent rhythmic 4-Hz EEG background activity is a consistent feature in some reports.<sup>1,8</sup> Fortunately,

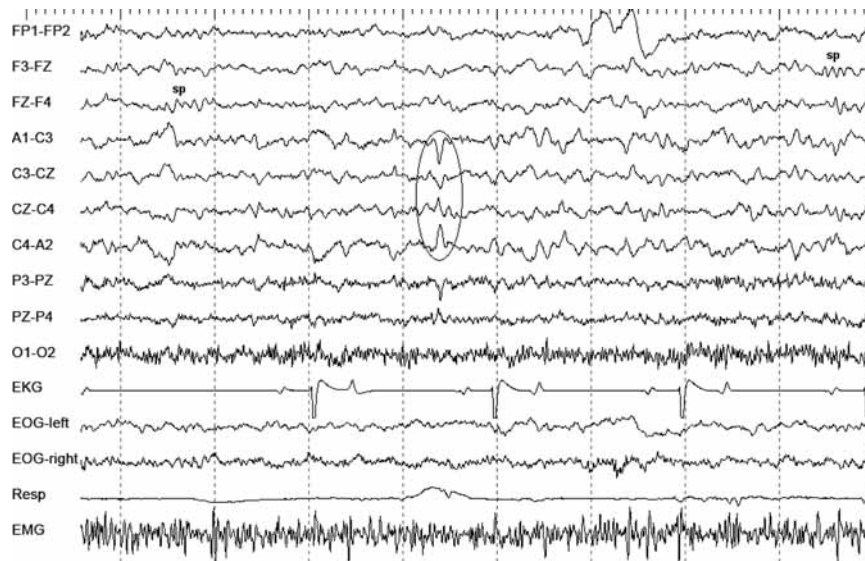


Fig. 2. EEG from a horse showing SWS.

the stance is very stereotyped: the horse supports its weight on both thoracic limbs and one pelvic limb and has the other pelvic limb primed, possibly to kick approaching predators. The head is initially held high. Some horses will carefully position themselves (often in the corner of a stall) and turn their head to look behind them before appearing to settle down.

What are presumed to be benign variants (those similar to recordings in human stage 1) have also been seen in equine EEGs.<sup>8</sup> Other normal transient events, sleep spindles and K-complexes, have been recorded in EEGs from horses and can be used to identify sleep (equivalent to light sleep in humans).<sup>8</sup> The gradual appearance of high amplitude delta activity is similar between species, and it signifies a deeper plane of sleep (human SWS [stages 3 and 4]).<sup>10</sup> In horses, the equivalent stages 2–4 of human sleep can be collectively referred to as SWS (Fig. 2).<sup>8</sup> This takes place with the horse in sternal recumbency (Fig. 3) or in the same stance as previously described for drowsiness but with the head held lower (withers height). Some studies have concluded that the former position is preferred, and the latter shows a lack of security with the environment or pain associated with attempts at lying down. Horses do not lie down for prolonged periods of time, which may be because of their body size and weight. Something unique to the horse during SWS is a second-degree heart block seen on the ECG.<sup>8</sup>

REM sleep is similar between species. In both, the pattern is of low voltage and mixed frequencies with episodic fast eye movements.<sup>8</sup> The loss of EMG activity is also observed, but in horses, the large splenius muscle of the neck is used instead of the chin muscle in humans.<sup>8</sup> The time spent in this stage is less than in humans; horses seem to devote

only 15% (~30 min/day) of their total sleep time to REM sleep. Lateral recumbency (Fig. 4) is commonly adopted, but sternal recumbency has also been observed. Recumbent REM sleep can be quite dramatic and may be confused with seizures. Some of the observed features during REM sleep may include paddling, twitching, blinking, developing rapid eye movement, ear twitch, and flaring nostrils. Brief segments of standing REM sleep have been documented, but the accompanying loss of muscle tone precludes extended periods of observation. Numerous partial-collapsing episodes related to REM sleep were observed in one of our research horses that refused to lie down (Fig. 5).<sup>8</sup> Horses that are standing during SWS have been known to



Fig. 3. Horse in SWS while in a sternal position.



Fig. 4. REM sleep in a neonate.

lie down and go into REM almost immediately. Although it may be tempting to call this sleep-onset REM sleep (SOREM), it is probably more closely related to microarousals, a normal finding in human sleep.

#### *Sleep Deprivation*

Sleep deprivation can be manifested in the horse as excessive daytime sleepiness and collapsing episodes (not to be confused with narcolepsy and catalepsy).<sup>12</sup> Like man, horses may be subjected to a variety of factors that can result in loss of sleep. Examples include environmental stress (excessive noise, extreme temperatures, and unfamiliar/unsafe territory), rank in the herd, and not lying down (lack



Fig. 5. Partial collapsing episodes when REM sleep occurred while standing. Photo reprinted with permission from the Journal of Veterinary Internal Medicine and Blackwell publishing.<sup>8</sup>

of REM sleep) among others. Horses imported from overseas and those exposed to stressful showing schedules for days may also experience sleep deprivation. Hospitalized patients, particularly those in an intensive care unit where there is constant traffic of personnel, horses, and equipment, are also at risk. We have observed at our hospital a few high-risk pregnant mares in their last month of pregnancy that do not lie down at all and have multiple episodes of knuckling and almost collapsing. One of these mares was witnessed to sleep continuously for 2 h after parturition. A few days later, this mare appeared normal. Compromised or anxious horses may avoid placing themselves in a position where they would be particularly vulnerable to predation. Wildlife (i.e., cougars, coyotes, and raccoons) may represent a threat for horses that could result in lack of sleep. Sleep deprivation may also be seen in dominant horses (who may be on constant alert) or horses at the bottom of the pack (who may be frequently disturbed by others). Introduction of new horses or removal of herd mates may inflict stress on the horse.

Horses suffering from medical conditions with some degree of pain, such as multiple degenerative joint disease (older horses), old fractures, chronic colic (i.e., enteroliths),<sup>12</sup> neurologic disease that may cause the horse to feel uncomfortable getting up and down, and others, may not lie down. A period of recumbency is necessary for healthy equine sleep, and the lack of it can lead to sleep deprivation in this species. In some cases, it may simply be a matter of inadequate bedding. Careful questioning of clients to get them to divulge important details is critical.

Regardless of the mitigating factor, sleep deprivation should be considered on the list of differential diagnoses if collapsing episodes are the primary complaint. Long-term video monitoring can be helpful in characterizing the episodes and determining if the horse is spending any time recumbent as well as the duration and behavior (resting quietly or sleeping) of the recumbency. Unexplained abrasions or scars on the dorsal aspect of the fetlocks and carpi may be the result of numerous unwitnessed episodes of collapse. Fortunately, the majority of cases of sleep deprivation can be corrected if the cause can be identified and addressed. A complete history and physical examination are essential to determine if a medical condition may be the sole cause or a contributing condition to the horse's lack of sleep. Pain management or a "bute" trial may provide information if the horse's falling sleep or collapses improve with treatment. Providing a safe, relaxing environment or even a companion may aid or resolve the problem.

After the precipitating factor has been addressed, the daytime sleepiness and collapsing episodes will resolve after the "sleep debt" has been repaid. Horses may sleep for excessive periods of time initially, and, as with humans, this greatly increases the amounts of REM sleep (referred to as REM rebound); however,

sleep should normalize within a few days. How much is adequate or enough sleep for a horse? Just like in humans, the amount of time for adequate sleep varies from horse to horse.

### Equine Sleep Disorders

#### *Hypersomnia*

Hypersomnia means excessive amount of sleepiness. In the horse, it is necessary to first rule out sleep deprivation before considering any other sleep disorder. These horses seem to have normal periods of sleep at the time of onset. These horses may lack periods of REM sleep despite being seen lying down, which can result in excessive episodes of sleep. A common complaint in these horses, besides excessive sleep, is decreased or poor performance. This disorder may be secondary to other diseases (i.e., endocrinopathies [pituitary pars intermedia dysfunction],<sup>13</sup> neurologic disease [viral encephalitis, brain trauma, EPM, etc.], or other diseases that have yet to be identified). However, the mechanisms and/or etiology of hypersomnia in the horse are unknown.

#### *Narcolepsy*

In humans, narcolepsy is a disabling sleep disorder characterized by excessive daytime sleepiness and abnormal REM sleep manifestations.<sup>14</sup> These manifestations include cataplexy (sudden loss of muscle tone triggered by strong emotions [humor, surprise, or anger]), sleep paralysis, and hypnagogic (sleep-onset) hallucinations. Cataplexy is specific to narcolepsy and is the best diagnostic marker of the disease; however, narcolepsy can also occur without cataplexy. Narcolepsy and cataplexy are strongly associated with the human leukocyte antigen (HLA) allele DQB1\*0602.<sup>14</sup> Hypocretins are neuropeptides, also known as orexins, produced in the lateral hypothalamus and are important in the regulation of sleep and wakefulness.<sup>14</sup> Although most cases of human narcolepsy are not caused by hypocretin gene mutations, patients with narcolepsy and cataplexy have low concentrations of hypocretin-1 in the cerebrospinal fluid.<sup>14</sup> In dogs, narcolepsy and cataplexy have been triggered by emotions such as play and excitement associated with food. The disorder in dogs is caused by mutations in the hypocretin receptor-2 gene.<sup>15</sup> A test helpful in the diagnosis of human narcolepsy is called the Multiple Sleep Latency Test (MSLT) and is based on the time it takes for a person to fall asleep during the day at each of several nap sessions spaced 2 h apart.

In horses, sleep deprivation is commonly referred as “narcolepsy.” However, they are different conditions that result from different causes. Because of the low numbers of narcoleptic cases, an underlying cause has not been identified in horses. Two experts in human sleep disorders, Mignot and Dement,<sup>16</sup> wrote that the “fact that cataplectic episodes

are triggered by emotions, usually positive, is then crucial for the diagnosis.” This was taken from an editorial in the *Equine Veterinary Journal* in 1993.<sup>16</sup> Despite this quote, sleep deprivation has been commonly confused with narcolepsy.

Familial narcolepsy has been documented in Miniature horses.<sup>17</sup> There have also been sporadic (anecdotal and documented) cases in other breeds. Increased somnolence or narcolepsy-like episodes has been reported in horses with pituitary pars intermedia dysfunction.<sup>13</sup> Similar to humans, diseased horses have low concentrations of hypocretin-1 in cerebrospinal fluid.<sup>13</sup> One author (MA) witnessed a 2-mo-old Lippizan filly with excessive daytime sleepiness triggered by excitement. This filly had “sleep attacks” when turned out in a pasture with her dam. The filly made attempts to play and follow mom at a gallop, but she struggled to stay awake while playing. Her constant “sleep attacks” prevented her from normal foal activities. In one report, a horse was said to “fall in a heap” after being startled. In another case, a 6-wk-old pony crossbreed had frequent episodes of falling sleep and collapse triggered by excitement (play time and going to pasture with mom), eating (nursing and chewing hay), and drinking that almost caused the colt to drown.

A complete physical, laboratory, and other diagnostic work-up in horses with collapsing episodes is needed because there could be other causes of collapse (e.g., rule out cardiovascular, respiratory, and neurologic conditions as well as electrolyte derangements). Again, video monitoring and keeping good records of the sleep behavior of a suspect narcoleptic horse is important.

### 4. Discussion and Conclusion

Sleep deprivation is common in horses. Other sleep disorders may be less common, not recognized, or poorly understood. If a sleep disorder is suspected in a horse, documenting the events associated with the onset of such problems may be helpful. Note possible triggering events, if any, like environmental conditions, housing (stall versus outdoors), bedding, introduction of new horses, isolation, removal of a herd mate, wildlife in the area, traveling, horse’s behavior, painful conditions, medical problems, and the behaviors of other horses. Video recording is helpful to document behaviors while the horse sleeps, and it is certainly needed for the best clinical assessment. Besides witnessing excessive daytime sleepiness in the horse, a clue that the horse may have a sleep disorder is the presence of abrasions or scars in the dorsal aspect of both fetlocks and carpi. Decreased performance may be associated with unhealthy sleep if other causes are ruled out. Because sleep deprivation is more common than other sleep disorders, it is necessary to first rule out this disorder. Sleep in the horse is essential for its overall health just as it is for humans. Limited information and/or understanding of sleep and associated disorders may lead to inaccurate diagnosis and management.

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