

Equine Behavior

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The Characteristics of Equine Sleep

□ Horse owners frequently ask the following questions concerning sleep:

- Can horses sleep on their feet?
- How long do horses sleep?
- When do they sleep?
- Do they dream?

Practitioners should be concerned about certain aspects of sleep. For instance, horses that are cross-tied to prevent them from disturbing a wound, may be badly sleep-deprived if the treatment is continued for many days.

Sleep can be identified behaviorally as a period of immobility in which the horse is relatively unresponsive to external stimuli, but sleep can better be defined on a neurophysiological basis. To study the neurophysiological basis of sleep, electrodes are positioned over the frontal epidural, occipital and parietal regions of the cortex in order to record cortical brain waves.¹ The electroencephalographic characteristics of wakefulness in the horse are low voltage (10-30 μ V) fast activity (25-40 c/sec) desynchronized

waves termed LVFA. During wakefulness an electrode implanted in the dorsal hippocampus shows an irregular theta rhythm with periods of small irregular activity. During periods of alert wakefulness (i.e. when another horse was seen or an unaccustomed sound heard) the hippocampal activity was characterized by regular synchronized high amplitude waves (150-200 μ V) of a low frequency (3-6 c/sec). As the horse becomes drowsy, spindles begin to appear in the frontal lead of the electrocorticogram (ECoG), that is, high amplitude, slow waves fade in and out.

At the hippocampal level, large (250 μ V) slow (1 c/sec) waves progressively replace the irregular theta waves. As the horse falls asleep, cortical spindle activity alternates with high voltage slow activity waves (200 μ V, 1-4 c/sec) (HVSA).

Sleep is divided electrophysiologically into Slow Wave Sleep (SWS) and Paradoxical (PS) or Rapid Eye Movement (REM) sleep. During SWS the HVSA synchronized waves

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predominate in the cortex and slow waves of high amplitude are also recorded from the hippocampus. The electromyogram (EMG) during SWS indicates that there is still some muscle tone and activity. The electrooculogram (EOG) measures the change in the electric field generated by the movement of the eye. During SWS the EOG indicates that there is very little eye movement, and the lids may be partly open. In contrast, during PS there are eye movements (hence the term REM) behind closed lids, but muscle tone is lost. The ECoG features of PS are low voltage fast activity. Both the electrical activity of the cortex and of the hippocampus resemble that of wakefulness, yet the horse is least responsive to external stimuli during PS. Paradoxical sleep is sometimes termed the sleep of the body because of the general muscular relaxation while slow wave sleep is known as the sleep of the mind.

Dreaming

Human PS is associated with dreaming. There is no way of determining whether horses dream during PS, much less determining the subject of their possible dreams. In addition to the burst of rapid eye movement, twitching of the ears, contractions of the limbs and occasionally whinnies, tachycardia and polypnea are observed during PS indicating that the horse may indeed be dreaming. The polygraphic characteristics of equine sleep are shown in Figure 1.

Sleep in horses has several unique characteristics:

- ▶ As far as we know adult horses sleep only at night, although they may drowse during the day. Ruminants sleep mostly at night, but do not appear to be strictly limited to night sleeping.
- ▶ The sleep cycle of horses is very short. The usual cycle consists of 5 minutes of SWS, 5 minutes of PS and another 5 minutes of SWS. The horse will then awaken and remain awake for about 45 minutes before another sleep cycle begins.
- ▶ The total sleep time is very short, aver-

TELMIN* B

(mebendazole-trichlorfon)
Equine Wormer

Brief Summary (For full information, see package insert.)

Indications: Telmin B Equine Wormer is indicated for infections of bots (*Gastrophilus intestinalis* and *G. nasalis*); large roundworms (*Parascaris equorum*); large strongyles (*Strongylus edentatus*, *S. equinus*, *S. vulgaris*); small strongyles, and pinworms (*Oxyuris equi*).

Warnings: Not for use in horses intended for food. Not for human use. If swallowed by a human, immediately call physician, poison control center or hospital emergency room. Upon medical advice, induce vomiting with ipecac syrup. If ipecac is not available, give milk or water and induce vomiting by touching the back of the throat with finger or blunt object. Avoid prolonged or repeated contact with the skin. Wash hands after use. Keep out of reach of children.

Precautions: Use only as directed. Do not administer more than once every 30 days. Do not treat sick or debilitated animals, foals under 4 months of age or animals used for breeding purposes. Symptoms of overdosage are ataxia and colic.

Trichlorfon is a cholinesterase inhibitor. Do not administer Telmin B Equine Wormer to animals simultaneously or within a few days before or after treatment with or exposure to cholinesterase-inhibiting drugs, pesticides or chemicals. Do not administer intravenous anesthetics, especially muscle relaxants, concurrently with Telmin B.

Notice to Physicians, Veterinarians: Trichlorfon is a cholinesterase inhibitor. Atropine is an antidote; give after cyanosis is overcome and to effect. 2-PAM is a supplemental treatment. Do not walk patient or give morphine.

Dosage and Administration: Prepare individual doses and administer via stomach tube or on the feed.

Caution: Federal law restricts this drug to use by or on the order of a licensed veterinarian.

How Supplied: Cartons of ten 12 g or 24 g packets.

TELMIN*

(mebendazole) Equine Wormer

Brief Summary (For full information, see package labeling.)

Indications: Telmin (mebendazole) is indicated for infections of: Large roundworms (*Parascaris equorum*); large strongyles (*Strongylus edentatus*, *S. equinus*, *S. vulgaris*); small strongyles and pinworms (*Oxyuris equi*), including many larval stages.

Warning: Not for use in horses intended for food.

Dosage and Administration: The recommended dose of mebendazole for horses is 8.8 mg/kg body weight.

How Supplied: Telmin (mebendazole) Equine Wormer is available in cartons of ten 6 g or 12 g packets and in 384 g containers. Telmin (mebendazole) Syringe Formula Equine Wormer is available in cartons of twelve 0.9 oz. (25 g) individually wrapped dial-dosage syringes. Telmin (mebendazole) Suspension Equine Wormer is available in one gallon plastic bottles.

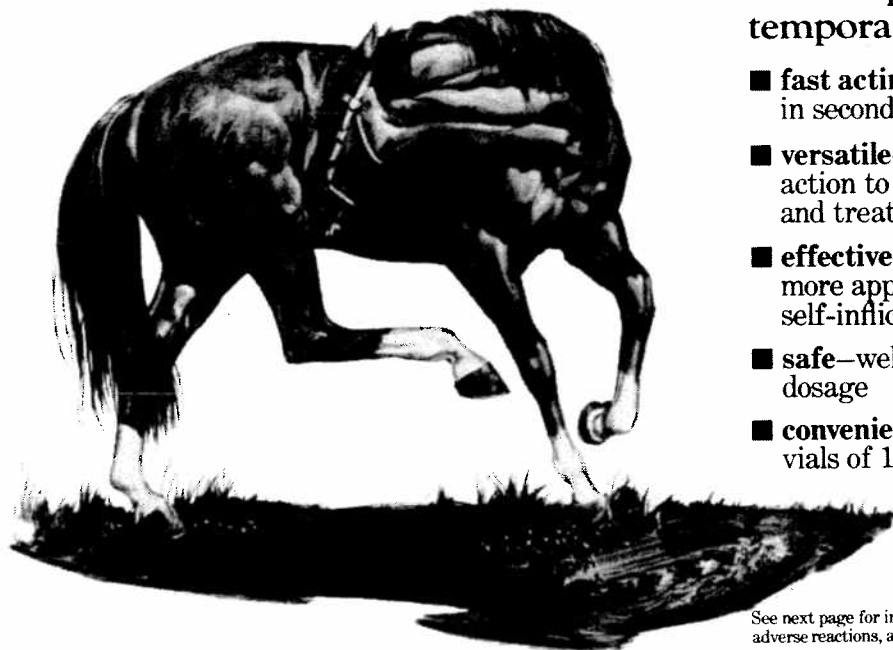
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- **fast acting**—just 5 ml IV gives relief in seconds; effect lasts 20 to 30 minutes
- **versatile**—5 ml IM yields prolonged action to facilitate examination and treatment
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See next page for important prescribing information concerning dosage, warnings, adverse reactions, animal patient selection, and precautionary recommendations.

aging about 3 hours per night. This represents even less sleep time than that of ruminants. Pigs, dogs and cats sleep for many more hours than horses.

- ▶ Although the total sleep time is short, the length of PS sleep bouts (and the ratio of SWS to PS) is longest in the horse. Figure 2 is a schematic representation of sleep patterns in horses. Of course, sleep cycles would not be as regular in an individual animal.

Sleeping Posture

Horses stand many hours during the day and even at night 80% of their time is spent standing. The stay apparatus allows horses to rest, drowse and even engage in SWS, but horses must be recumbent (usually lateral recumbency) in order to engage in PS. The movements of a horse in lying down and standing up are very consistent, in fact they are almost stereotyped. Horses usually are in sternal recumbency during SWS, sometimes with their muzzle resting on the ground.

When in lateral recumbency, the upper foreleg is always cranial to the under leg. The postures of the horse as it lies, sleeps and arises are shown in Figure 3. The clinical significance of the sleeping posture of the horse is that an animal forced to stand will be sleep deprived. For that reason sleep deprivation accompanies transportation when the horse must stand all night in a trailer or airplane. Horses that must be suspended in slings for many days will also be sleep deprived. A horse that has been tied so that it cannot lie down may show abnormal behavior as a result. The effects of PS deprivation have not been systematically made in horses, but in other species, including humans and laboratory animals, sleep deprivation leads to hyperirritability, learning deficits and even hallucinations. Horses deprived of PS will show a rebound or an increase in PS after deprivation which further indicates the importance of PS. Sleep time is short in horses, but apparently essential, nonetheless. In the days when many horses were kept in straight stalls, tied short so that they could not lie

down, they must have suffered chronic sleep deprivation. It may be possible for a horse to adapt to such conditions and exhibit PS while standing, but this has not been demonstrated in the laboratory.

Factors Affecting Sleep

Many factors affect sleep in horses. When deprived of visual and auditory stimuli, horses exhibit more SWS and a large increase in PS after the period of perceptual deprivation. When their diet was changed from one of hay (high roughage) to one of oats (high concentrate), ponies slept more and were awake less. Fasting also increases sleep time. The environment is probably

most important in influencing sleep patterns. Horses assume recumbency only in a familiar environment; therefore when put out on pasture it may be a day or two before a horse first lies down. This hesitancy to lie down in a strange place has obvious survival value for a prey animal such as the horse. Because horses are herd animals their behavior often shows social facilitation; that is, if one horse who is familiar with the environment lies down, the others will too. The dominant animal is usually the first to lie down.³

The anatomical and biochemical basis of sleep has been studied mostly in rodents and cats, although goats were used to demonstrate the humoral basis of sleep. The cerebrospinal fluid of sleep-deprived ani-

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Talwin-V[®] C^{IV} brand of pentazocine lactate injection, USP



Brief Summary

Note: Before prescribing, please consult full prescribing information.

Talwin[®]-V C

Brand of pentazocine lactate injection, USP

Analgesic for Veterinary Use.

Warnings: Not for use in horses intended for food. Not for human use.

Precautions: TALWIN-V is indicated only for the control of pain due to various types of colic in horses. Relief of colicky signs results from the analgesic effect of TALWIN-V. Appropriate measures for the treatment of colic should be instituted as soon thereafter as possible.

Adverse Reactions: Horses receiving larger than the recommended doses, especially by the intravenous route, have exhibited mild to moderate adverse reactions consisting of transient incoordination, ataxia, and nervousness.

Dosage and Administration: Generally effective in acute equine colic in single IV injection at 0.15 mg/lb (equivalent to 5 ml per 1000 lb) which may be repeated IM in 10 to 15 minutes in case of severe pain.

Supplied: Multiple-dose vials of 10 ml, each 1 ml containing pentazocine lactate equivalent to 30 mg base.

Caution: Federal law restricts this drug to use by or on the order of a licensed veterinarian.

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W-2684R

BANAMINE® (brand of flunixin meglumine)

Solution—50 mg./ml. Veterinary

For Intravenous or Intramuscular Use in Horses Only

Description Each milliliter of BANAMINE contains flunixin meglumine equivalent to 50 mg. flunixin, 0.1 mg. edetate disodium, 2.5 mg. sodium formaldehyde sulfoxylate, 4.0 mg. diethanolamine, 207.2 mg. propylene glycol; 5.0 mg. phenol as preservative, hydrochloric acid, water for injection q.s.

Activity Flunixin meglumine is a potent, non-narcotic, non-steroidal, analgesic agent with anti-inflammatory and antipyretic activity. It is significantly more potent than pentazocine, meperidine and codeine as an analgesic in the rat yeast paw test. Flunixin is four times as potent on a mg. per mg. basis as phenylbutazone as measured by the reduction in lameness and swelling in the horse. Plasma half-life in horse serum is 1.6 hours following a single dose of 4.1 mg/kg. Measurable amounts are detectable in horse plasma at 8 hours post-injection.

Toxicity Toxicity studies were conducted in horses. A threefold intramuscular dose of 1.5 mg. per pound body weight daily for 10 consecutive days was safe. No changes were observed in hematology, serum chemistry or urinalysis values. Intravenous dosages of 0.5 mg./lb. daily for 15 days; 1.5 mg./lb. daily for 10 days; and 2.5 mg./lb. daily for 5 days produced no changes in blood or urine parameters. No injection site irritation was observed following intramuscular injection of the 0.5 mg./lb. recommended dose. Some irritation was observed following a 3-fold dose administered intramuscularly.

Indications BANAMINE is recommended for the alleviation of inflammation and pain associated with musculoskeletal disorders in the horse.

It is also recommended for the alleviation of visceral pain associated with colic in the horse.

Dose and administration The recommended dose for musculoskeletal disorders is 0.5 mg. per pound (1 ml./100 lbs.) of body weight once daily. Treatment may be given by intravenous or intramuscular injection and repeated for up to five days. Studies show onset of activity is within two hours. Peak response occurs between 12 and 16 hours and duration of activity is 24-36 hours.

The recommended dose for the alleviation of pain associated with equine colic is 0.5 mg. per pound of body weight. Intravenous administration is recommended for prompt relief. Clinical studies show pain is alleviated in less than 15 minutes in many cases. Treatment may be repeated when signs of colic recur. During clinical studies approximately 10% of the horses required one or two additional treatments. The cause of colic should be determined and treated with concomitant therapy.

Contraindications There are no known contraindications to this drug when used as directed. Intra-arterial injection should be avoided. Horses inadvertently injected intra-arterially can show adverse reactions. Signs can be ataxia, incoordination, hyperventilation, hysteria and muscle weakness. Signs are transient and disappear without antidotal medication within a few minutes.

Precautions The effect of BANAMINE on pregnancy has not been determined. Studies to determine activity of BANAMINE when administered concomitantly with other drugs have not been conducted. Drug compatibility should be monitored closely in patients requiring adjunctive therapy.

Warning Not for use in horses intended for food.

Side effects During clinical studies no significant side effects were reported.

How supplied BANAMINE Solution, 50 mg./ml., is available in 50 ml. multidose vials, boxes of 1 and 6. July 1977

BANAMINE® (brand of flunixin meglumine)

Granules—250 mg. Veterinary

For Oral Use in Horses Only

Description Each 10 gram packet of BANAMINE Granules contains flunixin meglumine equivalent to 250 mg. flunixin.

Activity Flunixin meglumine is a potent, non-narcotic, non-steroidal, analgesic agent with anti-inflammatory and antipyretic activity. It is significantly more potent than pentazocine, meperidine, and codeine as an analgesic in the rat yeast paw test. Oral studies in the horse show onset of flunixin activity occurs within two hours of administration. Peak response occurs between 12 and 16 hours and duration of activity is 24 to 36 hours.

Toxicity No toxic effects were observed in rats given oral flunixin in 2 mg./kg./day for 42 days. Higher doses produced ulceration of the gastrointestinal tract. The emetic dose in dogs is between 150 and 250 mg./kg. Flunixin was well tolerated in monkeys dosed daily with 4 mg./kg. for 56 days. No adverse effects occurred in horses dosed orally with 1.0 or 1.5 mg./lb. for fifteen consecutive days.

Indications BANAMINE is recommended for the alleviation of inflammation and pain associated with musculoskeletal disorders in the horse.

Dose and administration The recommended dose is 0.5 mg. per pound of body weight once daily; i.e., one packet per 500 pounds. The granules are easily administered by sprinkling on a small amount of feed. Treatment may be given initially by intravenous or intramuscular injection of BANAMINE Solution, followed by BANAMINE Granules on Days 2 to 5. BANAMINE treatment should not exceed five consecutive days.

Contraindications There are no known contraindications to this drug when used as directed.

Precautions The effect of BANAMINE on pregnancy has not been determined. Studies to date show there is no detrimental effect on stallion spermatogenesis with or following the recommended dose of BANAMINE.

Warning Not for use in horses intended for food.

Side effects During clinical studies, no significant side effects were reported.

How supplied BANAMINE Granules, 250 mg. are available in 10 gram packets, box of 50. June 1979. Copyright © 1979

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mals induced sleep when infused into other animals.² Several neurotransmitters have been implicated in sleep. Both norepinephrine and acetylcholine appear to be involved in PS sleep as well as in wakefulness. Anatomically, the reticular activating system is necessary for wakefulness. Transection of the brain stem just behind the origin of the oculomotor nerves abolishes wakefulness in cats. Apparently neuronal impulses travel to the reticular activating system as well as to the sensory cortex. If the external stimuli are strong enough, the reticular activating system will be stimulated to send impulses to higher CNS areas and the ECoG will shift from the pattern of sleep to that of wakefulness. Lesions of the brain stem can abolish PS sleep.

Purpose of Sleep

The final question to be answered is "Why do horses (or other animals) sleep?" Many behaviors have an obvious function. Sexual behavior functions in reproduction, ingestive behavior in nutrition of the organism, etc. Sleep is a behavior that occurs in all mammals, and it occupies a major portion of the 24 hours of such species as the pig and dog. It is easily recognized by the most casual observer, nevertheless the function of sleep remains obscure. There are several hypothetical functions of sleep:

- sleep serves the function of maintaining immobility at times when immobility is an optimum survival strategy.
- sleep is a restorative process.

The first hypothesis is supported by the finding that exposed prey animals sleep less than predators, but that burrowing prey animals sleep more. PS is correlated with overall danger to the species so that PS is disadvantageous to those animals subjected to heavy predation because the animals are minimally responsive at that time. SWS is negatively correlated with body size. The smaller the animal and the higher its metabolic rate, the more it sleeps. SWS is a mechanism for enforcing rest and conserving energy. Large herbivorous animals like the

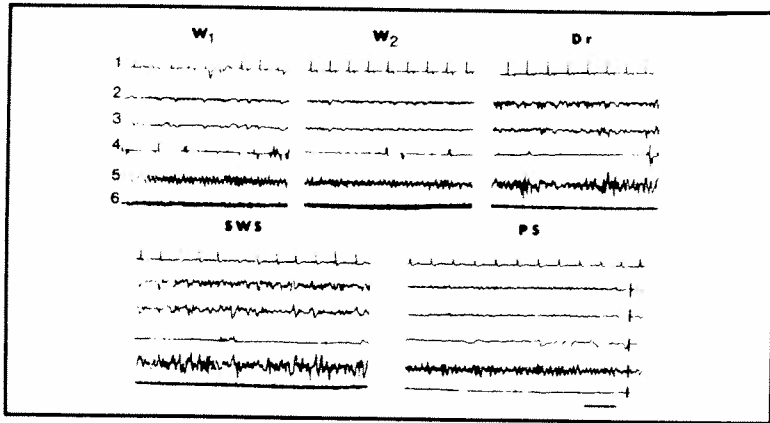


Fig. 1 — Polygraphic characteristics of alert wakefulness (W_1), quiet wakefulness (food intake: W_2), drowsiness (Dr), slow wave sleep (SWS) and paradoxical sleep (PS). 1: EKG; 2: Occipital EEG; 3: Frontal EEG; 4: EOG; 5: Hippocampus; 6: EMG. Calibration 1 sec, 100 μ V. (Reprinted with permission from Dallaire and Ruckebush 1974.)

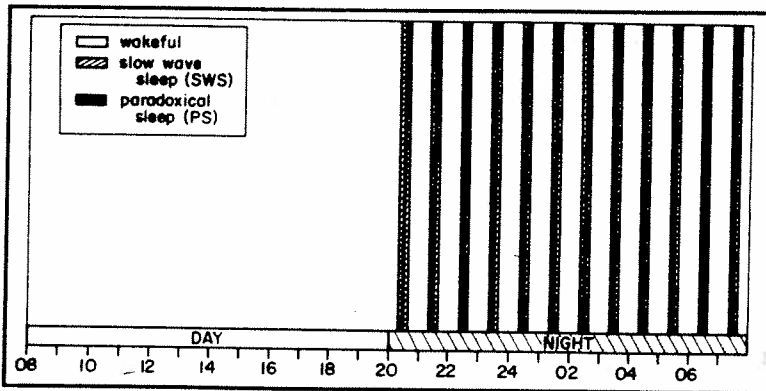


Fig. 2 — A schematic representation of sleep and wakefulness patterns in the horse. Horses are awake almost all of the time during the day. At night they sleep, but only for a few minutes at a time. PS or REM sleep is preceded and followed by SWS sleep. The horse is awake and on its feet for part of each hour, even at night. The cycles would not be as regular in real life as those depicted here.

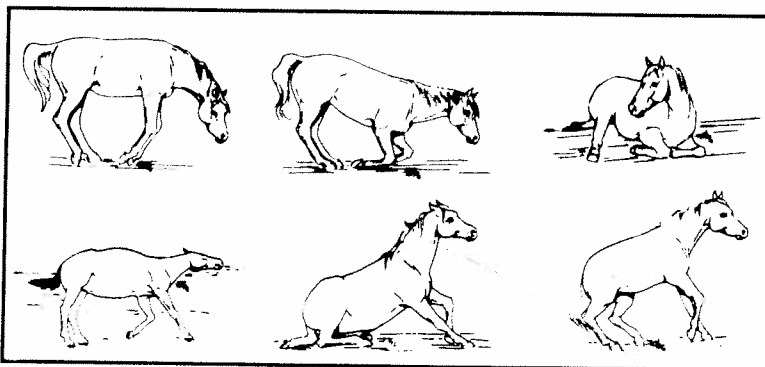


Fig. 3 — The postures of the horse when lying down, sleeping and arising. Top: The horse lies down by flexing its forelegs first. When lying in sternal recumbency the lateral aspect of the leg on one side (in this case the left side) is flat on the ground. The horse does not lie symmetrically on its sternum as a cat does. The horse is usually in sternal recumbency during SWS. Bottom: The horse lies in lateral recumbency during PS. The upper foreleg lies anterior to the lower one. When getting up the forequarters are raised before the hindquarters.

horse need not conserve energy, but rather must devote time to consuming a large quantity of calorically dilute food; therefore they do not sleep many hours. More time is available for sleep when horses are consuming concentrates.

The evidence that sleep is restorative is based on the fact that there is increased cell division and increased output of growth hormone during sleep. Young animals sleep more, perhaps for this reason. The sleep time of the foal decreases from nearly half the daylight hours at birth to the adult level by 7 months.

Conclusion

In summary, horses sleep 3 hours of each 24 hours, mostly at night, but they sleep for only brief periods. They sleep when recumbent, maintaining sternal recumbency during SWS and lateral recumbency during PS. Two hours a day are spent drowsing and this increases in warm weather. Sleep in horses is affected by changes of diet and by environmental disturbances. Whether or not horses dream, their sleep is important for normal growth and behavior. ■

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