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The Influence of Bedding on the Time Horses Spend Recumbent

Gunhild Riemann Pedersen, DVM,[a] Eva Søndergaard, PhD,[b] and Jan Ladewig, DVM, PhD[a]

SUMMARY

To determine if bedding has any influence on the time horses spend recumbent, 8 horses kept on straw and 8 kept on wood shavings were observed from 10:00 PM to 5:30 AM for two successive nights. Observations were conducted using time-lapse video recordings. Lying down and rising behavior, as well as frequency and duration of bouts spent in lateral and sternal recumbency, was registered. The results showed that horses on straw were lying in lateral recumbency three times longer than horses on shavings ($P < .001$), whereas the time horses spent in sternal recumbency did not differ. The longest period of noninterrupted lateral recumbency was longer for horses on straw than for those on shavings. Because horses must lie down, preferably in lateral recumbency, to achieve paradoxical sleep, the reduced time spent in lateral recumbency in horses on wood shavings may affect their welfare and performance. Independent of the bedding, we further observed that, as the horses got up from recumbency, most of them made attempts to roll over before rising. This behavior appeared to be caused by some difficulty in rising, possibly due to the box size, and might have a connection with the fact that horses sometimes get stuck against the box wall.

Keywords: *Horse; Bedding; Sleep; Recumbency; Welfare; Performance*

INTRODUCTION

Many riding horses spend the majority of their life in an artificial environment. Horse owners keep their horses under certain conditions because of tradition, because they want to make the horse feel comfortable from a human point of view, or to reduce the amount of work involved in horse husbandry. Often the choice of bedding substrate is made from a subjective point of view without assessing both short-term and long-term effects of the bedding. Part of the reason is that only few studies have analyzed horses' preferences for different bedding substrates and their effect on the time horses spend recumbent. In one study comparing straw and wood shavings, no significant preference was found.[1] In another study comparing plastic, wheat straw, and wood shavings, the time horses spent standing, sleeping, or lying down was not affected significantly by the bedding substrates.[2] Mills et al[3] found that horses, given a choice between straw and wood shavings, spent significantly more time on straw. Whereas the substrates had no significant effect on behaviors such as eating, lying, and standing alert, horses spent more time performing bedding-directed behaviors on straw but more time dozing on shavings. Finally, it has been reported that the use of nonstraw bedding may increase the risk of abnormal behaviors such as weaving.[4]

As far as bedding properties are concerned, Airaksinen et al[5] concluded that air quality in the stable and utilization of manure can be improved by selecting a good bedding material. According to Reed and Redhead,[6] both straw and shavings are economical and easy to obtain, and they make a bright, comfortable bed. Straw bales are convenient to store, but may be eaten by the horse, are labor intensive, and may be dusty or contain fungal spores. Wood shavings are not eaten by the horse and are good for respiratory problems but need to be kept very clean because they are porous. In addition, they are not as warm as straw because they do not trap air the way straw does.

Electroencephalographic (EEG) studies in cats have demonstrated that sleep can be divided into two stages of differing electrocorticographic (EcoG) patterns, ie, slow-wave-sleep (SWS) and paradoxical sleep (PS).[7] During PS, bursts of rapid eye movements (REM) can be seen at irregular intervals.[8] In humans, dreaming occurs during

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this stage.[9,10] Horses are able to sleep while standing,[11] but in this position they only go into SWS.[14-16] During PS there is a complete abolition of muscular tone of antigravity muscles and of neck muscles, as shown in cats.[17] In horses, there is a gradual loss of muscular tone until the middle of the recorded SWS period, whence it decreases to a negligible amount during PS.[15] Consequently, muscular tone disappears entirely at the onset of PS.[18] Horses are unable to complete a sleeping cycle without lying down to enter PS.[8,19,20] They normally fall asleep while standing and, when they feel confident about their environment, lie down in sternocostal recumbency.[8] Thereafter, they proceed to lateral recumbency and enter PS.[14,19] Dallaire and Ruckebusch[18] demonstrated that the SWS state was infrequent in the standing animal and most often occurred during sternocostal recumbency with the head resting or not on the ground. PS occurred in both sternocostal and lateral recumbency, although the animal frequently had to readjust its position into sternocostal recumbency due to the disappearance of neck muscular tone.

The sleep pattern of horses depends on many circumstances, such as age,[21-23] diet,[16] and familiarity with the environment. When horses are put outdoors it may take some days before they lie down. If one horse that is familiar with the environment lies down, the others usually follow.[8,13] Dallaire and Ruckebusch[16] subjected three horses to a four-day period of perceptual (visual and auditive) deprivation. After this period total sleep time increased due to an augmentation of both SWS and PS. Finally, there is large individual variation between horses in the time they spend recumbent and sleeping.[15]

Horses spend 11% to 20% of the total time in recumbency.[11,15] Lateral recumbency represents about 20% of total recumbency time, and uninterrupted periods of lateral recumbency vary from 1 to 13 minutes (mean, 4.6 min).[14,16] Steinhart[11] found that the mean length of uninterrupted lateral recumbency periods was 23 minutes, the longest period being one hour. Total sleeping time in the stabled horse averages 3 to 5 hours per day or 15% of the total time.[8,13,16] Keiper and Keenan[24] found similar time budgets in feral horses that were recumbent approximately 26% of the night. PS is about 17% to 25% of total sleeping time, and the mean length of a single PS period is 4 to 4.8 minutes.[13,18]

In stabled horses sleep is mainly nocturnal and occurs during three to seven periods during the night.[8,13,16] Ruckebusch[13] observed that neither sleep nor recumbency occurred during daytime in three ponies observed for a month and, in another experiment conducted on horses, PS occurred only during nighttime.[15] A group of ponies observed for more than a month between 8:45 AM and 4:45 PM spent only 1% of the daytime recumbent.[25] The maximum concentration of sleep occurs from 12:00 AM to 4:00 AM.[8,16,18,24]

The purpose of this study was to examine two groups of horses in a familiar environment, one group kept on a bedding consisting of straw, and the other kept on wood shavings, and to determine if there was any difference between the two groups in the time they spend recumbent.

MATERIALS AND METHODS

Housing. The study was conducted in one of the biggest riding clubs in Denmark, housing about 150 horses. The 18 horses used in the study stood in three different parts of the stable. They were all stabled in boxes measuring 3 × 3 m and subjected to the same feeding and management routine. They were unable to see their next-door neighbor because of a tall wooden board, but they were able to see the horses stabled on the opposite side of the corridor through bars. Nine horses were stabled on wheat straw (~15 cm long, dry matter content 87-88%) and nine on oven-dried wood shavings (80% spruce and 20% pine, dry matter content 82%).

Animals. All horses used in the study were privately owned. They had been kept in the boxes in which they were observed a minimum of three weeks. Three of the horses were mares and 15 were geldings. Most of them were Danish Warmblood used for dressage riding. Their ages ranged from 5 to 18 years (mean, 10.6 y) and their height ranged from 1.60 to 1.76 m (mean, 1.68 m). All horses wore a blanket. Age and sex distribution between the two groups is shown in Table 1.

Management. The stalls of horses stabled on straw were mucked out on Mondays and Thursdays, and stalls of those stabled on shavings were mucked out on Tuesdays and Fridays. Every morning fresh straw or shavings were added to the stalls. At 6:30 AM, 10:45 AM, and 4:30 PM, they were fed a mixture of oats and a supplement, and hay (dry or silage).

Recordings. The activity of each horse was recorded on a time-lapse video recorder set at one-fourth of normal speed. The video camera was mounted in the upper corner of the box. The light source was an infrared lamp placed in the middle of the corridor. The red light was chosen because of its low interference with the circadian rhythm of the animals.[26] Recordings were made between 10:00 PM and 5:30 AM, ie, when the lights were turned off until the caretaker arrived in the morning. Four horses were observed each night, except for two nights when only two horses were observed, and each night, an equal number of horses on shavings and on straw were observed. Recordings were done for two successive nights, starting on Mondays and Thursdays. This schedule meant

Table 1 Longest period of non-interrupted lateral recumbency and sternal recumbency, in minutes for each horse each night

Straw	Lateral recumbency	Sternal recumbency	Wood shavings	Lateral recumbency	Sternal recumbency
G, 7 y	27.3	29.0	G, 7 y	1.0	38.4
	29.5	37.0		8.2	46.1
G, 13 y	21.8	27.9	M, 7 y	6.5	35.2
	24.1	38.0		11.2	16.6
M, 7 y	31.0	28.8	G, 13 y	9.5	20.5
	32.9	21.6		8.2	27.6
G, 11 y	10.8	20.0	G, 12 y	8.0	17.1
	25.5	32.1		10.6	15.1
G, 18 y	15.9	23.0	G, 11 y	5.4	38.6
	*	*		6.8	31.0
G, 18 y	14.9	17.0	G, 13 y	11.6	32.3
	5.2	22.3		5.5	24.2
G, 5 y	18.2	13.3	G, 14 y	10.9	19.2
	24.4	20.0		0.4	19.6
G, 8 y	8.9	48.8	M, 7 y	0.0	29.1
	15.2	32.4		1.6	27.7
Mean ± SD	20.4 ± 8.4	27.4 ± 9.3	Mean ± SD	6.6 ± 4.0	27.4 ± 9.2

G, Gelding; M, mare.
**This horse was not recorded the second night because of technical problems.*

that on the first night the stalls of horses on straw had been mucked out, and on the second night of recording the stalls of horses on shavings had been mucked out.

Observations. From the video recordings it was registered how much time each horse spent in lateral and sternal recumbency, the total time of recumbency per night, and at what time recumbency was achieved. Sternal recumbency was defined as the asymmetrical sternoabdominal posture in which the lateral surfaces of the flexed underneath limbs are applied to the ground in such a way that the sternum and abdomen rest on the ground to the right or left of the midline, with the muzzle resting on the ground, a forelimb, or not at all. Lateral recumbency was defined as a right or left posture in which the upper forelimb is anterior to the lower forelimb, the hind limbs are extended, and the head is resting on the ground.[12] Furthermore, it was recorded how many times the horses progressed from one posture to another, how many times they laid down and stood up, and if they had any difficulty doing so. Because we observed that the horses sometimes made an attempt to roll over before rising, these attempts were also recorded. A *t* test was used to determine whether the difference between means were significant, conducted at $P < .05$.

RESULTS

Of the 16 horses observed, one was observed for one night only because of technical problems. Each horse was observed for an average of 7.2 hours per night.

The mean total time the horses spent recumbent did not differ between the two groups (166.8 min for horses on straw, and 133.8 min for horses on shavings, $P > .1$). The mean time spent in sternal recumbency was the same for the two groups (5.6 min). The time spent in lateral recumbency was almost three times longer for the horses on straw (mean, 57.5 min) than for those on shavings (mean, 19.3 min) ($P < .001$). There were consistent individual differences between the 16 horses in time spent recumbent, but there was no significant difference between the first and the second night of recording. The longest period of noninterrupted lateral recumbency was significantly longer for the horses on straw than for those on shavings ($P < .001$), and the longest period of noninterrupted sternal recumbency did not differ between the two groups (Table 1).

Most recumbent rest occurred from midnight until early morning; the horses did not spend much time recumbent before midnight (Fig 1). They would usually rise some time before the caretaker arrived in the morning. There was no difference between the two groups in relation to the time of night they lay down. In the beginning of the night the horses were mostly engaged with the bedding. Thereafter they appeared to become drowsy. Head and ears would drop and they would stand still for a long while. They would then wander around, apparently to find a good place to lie down and, finally, lie down in sternal recumbency. From the sternal position they would either rise again or shift to lateral recumbency. Usually

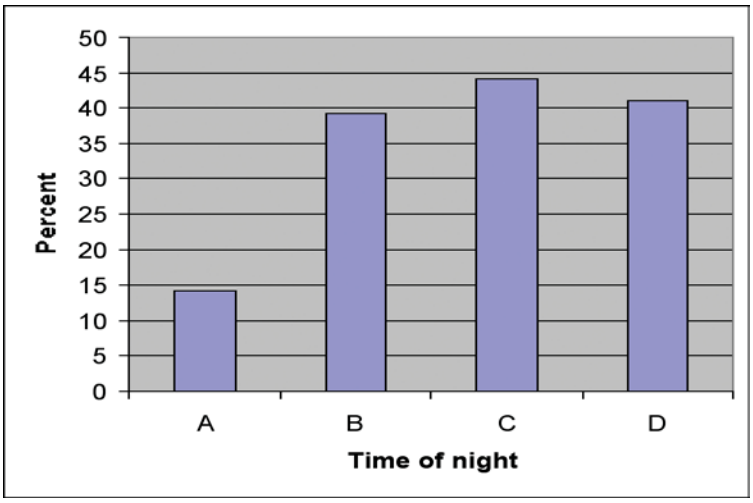

Figure. Mean percentage of time spent recumbent at various times of the night. **A**, 10:00 PM–12:00 AM; **B**, 12:00–2:00 AM; **C**, 2:00–4:00 AM; **D**, 4:00–5:30 AM.

the horses then altered between lateral and sternal recumbency (mean, 6 times), before getting up (Table 2). The horses had 2 to 4 favorite sites for achieving recumbency in the box. Mostly they laid close to the wall, sometimes making it difficult to progress from sternal to lateral position because the head bumped into the wall. Sometimes they would rest the head against the wall, a position that was considered lateral recumbency.

Before getting up from recumbency, almost all the horses seemed to make some attempts to roll over before getting up (Table 3). Of the 108 observed rising events, 34 (31.5%) were preceded by at least one rolling attempt. Thirteen of the 16 observed horses performed this behavior at least one time, but none of the horses performed it every time they rose. It seemed as if the horses tried to roll from one side to the other 1 to 4 times, but never succeeded in doing so. Immediately after these attempts the horses would rise normally. In slow motion it was obvious how some of the horses moved away from the box wall while performing the rolling. The behavior was independent of the type of bedding.

DISCUSSION

Although the total time horses spent recumbent did not differ significantly between those kept on straw and those kept on wood shavings, the time spent in lateral recumbency was three times longer for horses on straw than for those on shavings. The reason why a similar difference was not found in other studies may be due to the experimental design, in that the horses in our study were observed in a familiar environment, whereas horses in earlier studies were observed in unfamiliar environments. Because familiarity affects the time horses spend recumbent,[8,13] the experimental conditions may have affected the results in other studies.

Recumbency may be influenced by factors such as depth, softness, texture, cleanliness, smell, and insulation properties of the bedding material. The bedding used in the two observed groups was generally very clean, because the owners removed wet bedding and manure before leaving their horse in the evening, and neither the wood shavings nor the straw felt damp to the touch. Furthermore, the fact that all the horses wore a blanket may have influenced their perception of the bedding, both regarding the cleanliness and the insulation properties. It is thus possible that horses without blankets are more sensitive to the bedding, resulting in a bigger difference in time spent in lateral recumbency. The depth of the bedding varied between the horses, partly because those on straw would eat some of their bedding during the day, and partly because the amount of bedding material was not measured exactly. Subjectively, when stepping on the bedding, the wood shavings felt softer and more elastic than a bedding of straw. It is possible, however, that firm bedding is more natural to horses, or that the smell or texture of straw is more appealing than that of wood shavings.

The results of this study raise the question whether horses on shavings get less PS than those on straw. Considering that horses must lie down in lateral recumbency to enter PS, the horses on straw could have up to three times more PS than those on shavings. It has been reported that horses in the wild spend less time in lateral recumbency (2-9% of the night[21,22]) than stabled horses (5-15% observed in this study). It is most likely that the

Table 2 Frequency (mean) of different activities

Bedding	Mean No. of episodes getting up and down	Mean No. of episodes lateral recumbency	Mean No. of episodes sternal recumbency	Mean No. of episodes attempts to roll before rising
Straw	3.33	7.07	9.60	1.00
Wood shavings	3.62	6.06	9.13	1.19

Table 3 Number of episodes of attempts to roll before rising each night for each horse

Straw	G, 7 y	G, 13 y	M, 7 y	G, 11 y	G, 18 y	G, 18 y	G, 5 y	G, 8 y
Night 1	1	1	1	2	0	1	2	2
Night 2	1	1	1	0	*	0	2	0
Shavings	**G, 7 y**	**M, 7 y**	**G, 13 y**	**G, 12 y**	**G, 11 y**	**G, 13 y**	**G, 14 y**	**M, 7 y**
Night 1	1	2	1	1	0	0	0	0
Night 2	1	2	2	4	2	3	0	0

G, Gelding; M, mare.
**This horse was not recorded the second night because of technical problems.*

long uninterrupted episodes spent in lateral recumbency reflect horses that are relaxed and comfortable, and that the amount of PS these horses get is the amount that stabled horses need.

PS is sometimes termed the sleep of the body because of the general muscular relaxation, whereas SWS is known as the sleep of the mind.[27] Various hypotheses exist about the function of sleep, eg, that PS may play a role in maintaining the functioning of catecholamine-containing neurones in the central nervous system.[28] Oswald[29] proposes that PS is a nonspecific indication of many forms of syntheses within cerebral neurones. He suggests that the main function of SWS is for bodily restitution, while PS may be mainly for brain repair.

Various studies have analyzed whether sleep, and in particular PS, is a necessary and vital part of our physiologic and psychologic well-being. In man, deprivation of PS by awakening the subject at the onset of each PS episode led to psychologic disturbances such as anxiety, irritability, difficulty in concentrating, and an increased incidence of PS when sleep was again undisturbed.[10] In rabbits that were disturbed by noise during 24 hours, PS was almost completely inhibited, whereas SWS was not. After the noise period, the animals recovered the missing PS episodes, indicating that PS may be of fundamental physiologic importance.[30] In cats selectively deprived of PS, an increasing need for PS appears, and after more than 8 days of PS deprivation, behavioral disturbances such as drowsiness and hypersexuality may appear. In addition, during recovery from selective PS deprivation, a rebound of PS appears.[31] It is thus likely that PS is important in regard to productivity and performance, raising the question whether the welfare of horses bedded on shavings is in any way compromised, and whether these horses perform less effectively than those bedded on straw.

The owners of the horses in this study reported various reasons for keeping their horse on shavings. Some had chosen this bedding because they believed that their horse would become too fat if kept on straw. One horse once had colic when stabled on straw, another had an allergic reaction that might have been caused by straw, and a third horse suffered from respiratory problems. Finally, one owner thought shavings were more hygienic and easier to clean than straw. If horses' welfare is compromised when stabled on shavings, however, and their performance is reduced because of lack of PS, only few of these reasons seem to justify the use of wood shavings.

The time budget of recumbency of the horses in this study was very similar to that described by other authors.[8,16,18,24] The fact that most recumbency occurred between midnight and early morning explains why some horse owners are convinced that their horse never lies down, as they have never seen it doing so.

The rolling attempts observed in many of the horses before getting up have, to the best of our knowledge, never been described before. It is doubtful that the behavior has anything to do with grooming behavior. Instead, it appears to be an attempt to get away from the box wall in order to be able to make the forward movement to get up. If so, the observation gives rise to the question about box size. According to a Danish recommendation the length of the walls of the box on each side should be at least twice

the height of the horse, or rectangular with the same area, the shortest side not being under 1.5 times the height of the horse.[32] The boxes in this study were 3 × 3 m, and the height of the horses varied from 1.60 to 1.76 m. Thus, the box dimensions should have been a minimum of 3.2 × 3.2 to 3.5 × 3.5 m. It is possible, however, that horses lay down against the wall on purpose, either to feel safe or to avoid draft. Another possibility is that the horses end up lying against a wall because of their initial preparation to lie down. Thus, we observed that most horses followed the same pattern of wandering around in the box before lying down, apparently to find a good spot. This behavior naturally caused the horses to walk along the walls. In contrast, if they want to lie in the middle of the box, they have to perform a circling rather than a walking movement, an activity that may be somewhat uncomfortable for them. Whatever the reason for the rolling attempts, they increase the risk of the horse getting stuck against the box wall. In fact, it was reported by the caretakers that some of the observed horses had been found in the morning unable to get up, and that they had suffered injuries from their attempts to get up. Further experimentation is clearly indicated to analyze whether box dimensions influence this aspect of lying behavior in horses or whether a different box design may be necessary.

CONCLUSION

The total time spent recumbent did not differ significantly between horses bedded on straw and horses bedded on wood shavings, but the time spent in lateral recumbency was 3 times longer for the horses on straw. This result raises the question whether horses on shavings get less PS than those on straw and, if so, whether it affects the welfare and the performance of the horses. The observation that the horses made an attempt to roll over before rising, a behavior that has not been described before, further calls for continued studies of the lying behavior of horses, both for welfare reasons and because the behavior may be related to an increased risk of getting trapped against the box wall.

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