

Chapter 4

HOUSING, MANAGEMENT AND WELFARE

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Abstract. Horses tend to be housed in loose boxes, stalls, barns and shelters for ease of management, however these systems present several possible threats to equine health and welfare. These systems are reviewed together with the concerns they raise. A common system for the evaluation of the welfare of contained animals focuses on the provision of five freedoms. These are freedom from hunger, thirst and malnutrition, from discomfort, from pain, injury and disease, from fear and distress and to express most normal patterns of behaviour. This approach is used to assess the ways in which horse welfare may be compromised by certain housing practices and management regimes. Recommendations as to how these problems can be resolved and to promote good practice are provided.

1. Introduction

“It does not require any vast expenditure of thought to discover that life is action, ‘to be’ is synonymous with ‘to do’: therefore, it is a sheer necessity of existence that an animated being must be doing something. Such is the primary consequence of existence. Thus to breathe and to move imply one act; since, if the lungs cease to dilate, respiration immediately terminates, and, with it animation comes to an end. Yet it remained for mortal perversity to rebuke the first principle of established philosophy, when stables were built, in which a breathing animal was to be treated as it were an inanimate chattel.”

These strong words were written by James Lupton over 100 years ago (Lupton 1884) but are still a powerful reminder of the two main problems facing the stabled horse today: the aerial environment and the psychological impact of the stable on the horse. These factors therefore form the main focus of this chapter.

There are unique issues to be dealt with and challenges faced in housing horses, especially in comparison with other species. It is possible to extrapolate some principles of housing from farm animal species, however, there are situations where this approach is detrimental. For example, maintaining a warm environment for pigs and poultry can increase their production efficiency. There is a respiratory cost to the animals with this approach. However, even minor levels of respiratory disease can influence the performance of an equine athlete. In this situation respiratory health is more critical for horses than meat production animals. Horses are also generally longer living compared with the majority of farm animals, which are slaughtered when relatively young. Conditions such as the allergic respiratory

disease, chronic obstructive pulmonary disease (COPD or heaves) are primarily seen in older horses, ranging from best loved children's ponies to the most valuable bloodstock. Paying attention to the quality of the air which horses breathe has both short-term and longer term health and welfare implications for horses (Clarke 1987; Holcombe *et al.*, 2001).

Horses are also unique in the relatively low stocking density at which they are housed. Stocking density of intensively housed farm livestock has a major effect on the quality of the air that they breathe. By comparison, the quality of air horses breathe is primarily affected by the quality of the food and bedding that is provided and the management of bedding.

Shelter, grazing, shade and a source of water, are believed to be the key resources, that determine the core area requirements in the free-roaming horse (Tyler 1972). However, modern housing tends to focus on the provision of a safe, clean and cost-effective environment in which an animal can be managed conveniently and in a cost-effective way. Neither these owner-centred considerations nor the commonly cited justification for the need to conserve grazing, really recognise the health and welfare implications of housing a horse, which have the potential to be quite serious. Indeed horses may prefer not to be housed even in inclement weather. Schatzmann (1998) found that 5 horses provided with free access to a 15 acre paddock and box stall with straw bedding, hay and water all chose to stay outside during the Swiss winter, as long as some grass was available.

The evolutionary history of the horse reflects selection for a social species living in open plains where flight is the primary mechanism of escape from predation. It should not be surprising therefore, if there were to be an inherent aversion by the horse to the isolation and confinement associated with many housing systems (Mills & Nankervis 1999). Housing also poses a biological challenge to the normal mechanisms of health regulation in the horse. Enclosure inevitably involves an accumulation of potentially harmful substances in the aerial environment, by virtue of the restriction it imposes on the circulation of air around an active biological system (*i.e.* the horse, and its immediate environment). Recent studies (Jackson *et al.*, 2000; Holcombe *et al.*, 2001), have demonstrated that even in apparently healthy animals a greater level of upper and lower airway inflammation is seen when housed, and that this subsides when the animals are turned out. This suggests that housing may both psychologically and physically stress the horse, which, if not properly managed, can rapidly result in welfare problems. Different systems and practices pose different threats and so we start with a brief review of the systems available before we consider their impact on the psychological and physiological well-being of the horse.

2. Housing Systems and Their Impact on the Horse

Housing may be divided into four broad categories: stalls, loose-boxes, barns and shelter systems (Clarke 1994). Brief details of each, together with its effect on the behaviour of the horse are given below.

2.1. LOOSE BOXES (BOXSTALLS)

Loose-boxes are probably the most common form of housing used in Europe and North America, since they allow each animal to have its own space and personal management routine according to the wishes of individual owners. Boxes usually vary in size from 3 m by 3 m approximately for those designed to hold a pony, to 3.6 m by 3.6 m for larger horses and 5 m by 5 m for a foaling box. This allows the horse to walk around in the box, but provides a degree of confinement, which may restrict the normal level of movement of the occupant (see Figure 1). Social isolation may also be a problem in loose boxes which are often separated by solid full height walls. This sort of partition is commonly justified by the need to prevent cross infection of airborne pathogens. Alternatively, walls may contain grills or only be partial, to allow greater circulation of air and some degree of social interaction between boxes. Loose boxes may be part of a larger enclosed building with rows of units separated by a central passage. This type of building is colloquially known as an American Barn. In this case they all share a common airspace. Whilst this is commonly thought to be beneficial to the horse, through the provision of a less variable temperature and dry conditions, such buildings can be very difficult to ventilate effectively. The biggest challenge is ensuring that there is effective distribution of air throughout the building and that all stalls are adequately ventilated (Clarke 1987). Kiley-Worthington (1987) concluded that horses housed in loose-boxes even on ad libitum rations, spent more time standing (40% of time recorded)

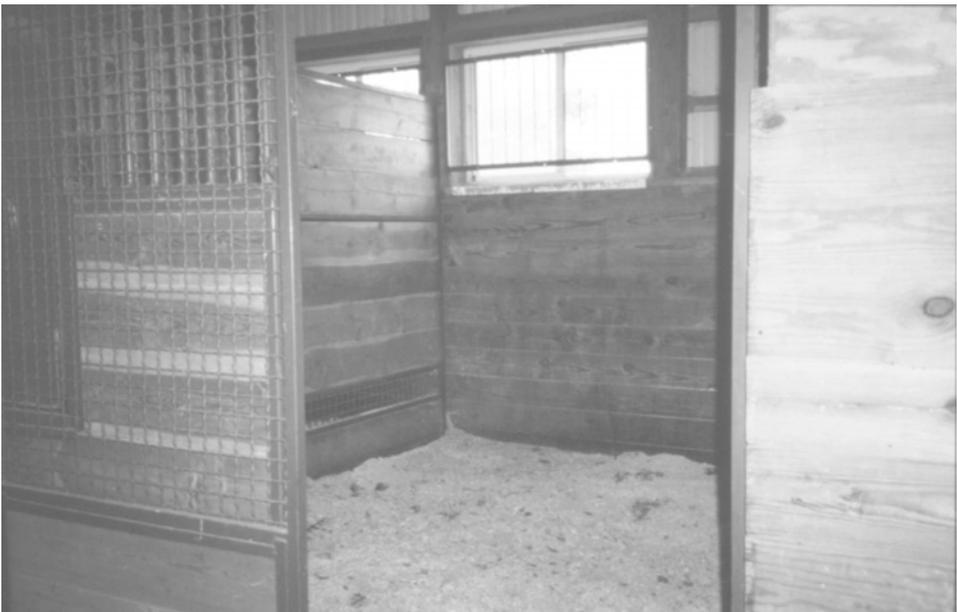


Figure 1. The stable/loose-box can restrict a horse's normal behaviour (courtesy of Natalie Waran).

and less time feeding (47% of recorded time) compared to free roaming horses. Feral horses have been observed to spend on average 20% of their time standing and 60% of their time eating (Duncan 1980), whilst domestic horses with free access to pasture are reported to spend more than two thirds of their time feeding (Crowell-Davis *et al.*, 1985). Boxing therefore interferes with the normal allocation of diurnal activity. Rees (1984) has suggested that the tendency to arrange boxes so that they face the main focus of activity interferes with the ability of horses to relax, and this may, at least in part, explain this effect. Thus on-going maintenance behaviours, such as feeding, may be continually interrupted by vigilance behaviour. Further, the arrangement of boxes around a central courtyard where they can see but not approach other horses, whilst often thought to be of benefit to the horse, may actually increase behavioural frustration or the aversiveness of the environment for some individuals (McAfee *et al.*, in press).

2.2. STALLS

Stalls and tethers involve tying animals via a head collar under some form of cover. Horses should be tied so that they can still lie down, but this system still imposes much greater restriction on movement. Partitioning may be such that animals are individually isolated, paired or in larger bays, but the dividing walls are not usually solid to the full height of the building. Therefore social isolation may not be as great as in many loose boxes, since horses are normally in closer proximity and able to view more of neighbouring conspecifics. Incidents of aggressive behaviour between horses in adjacent stalls can be managed by moving one or both of the individuals involved. A typical stall may be 2–2.5 m wide and 3 m long and should slope towards a drain and passageway at the rear of the horse. The slope should be the minimum required for effective drainage in order to reduce strain on the flexor tendons. The advantages of this system include the reduction in the space and bedding requirements and the resultant speed with which animals can be mucked out. However, the level of confinement imposed by this system, and the inevitable need to approach horses from behind are common causes for concern. Accordingly the system tends to be used where space and/or time is at a premium and with horses that are out at work for a large part of the day. Interestingly, horses kept in this system with ad libitum forage are reported to spend approximately 65% of their time feeding and 25% standing (cited in Ogilvie-Graham 1994), which is more similar to the reported time budgets of free roaming than loose housed horses. However, as expected, less time is spent lying in this system (3–6%, Ogilvie-Graham 1994) than in others (generally reported to be around 10%).

2.3. BARN/COVERED YARDS

There are two basic types of barns. The first is the so-called 'American-barn' where horses are housed in individual loose-boxes under one large roof (see above). The second system is the horse-barn in which horses are group housed. This system is cost effective and also relatively low maintenance. The horses may not be so clean

and some aspects of their health are more closely dependent upon that of other members of the group. The common airspace, high stocking density and tendency to use deep litter may all increase the risk of spread of disease, should it enter the system. Since horses are free to move and interact, it is not surprising that yarded horses fed ad libitum forage, have similar time-budgets to their feral counterparts (Kiley-Worthington 1987). The main concern with this system relates to the risk of injury from aggression, since stocking density may not allow an individual to withdraw from an agonistic encounter. This sort of interaction is more likely in an unstable social group, such as that which may exist on a public livery yard where there may be a frequent turnover of stock. However, large personal yards, foaling centres and horse farms can group together horses of similar age or individuals well known to each other in order to minimise this risk.

2.4. SHELTERS

Finally, there is the shelter and paddock system. This comprises of a simple, largely open-fronted building, which opens onto a paddock. It may vary from an extensive grassy paddock designed for several horses (field management system) to a more restrictive individual sand paddock (dry lotting). In the latter system, a yard may contain several units in a block for ease of management and there is much greater control over factors like feeding and cleanliness. All of these types of system are potentially cost effective and relatively low maintenance. Social isolation is obviously potentially less and the individual dry lotting system may circumvent many of the problems associated with group housing, although horses may still bite each other across a fence. Movement restriction is also less in these systems, but grass surfaces may be prone to poaching and spoiling in cold, wet conditions.

Further details on the principles of construction and design can be found in Sainsbury (1987).

3. Assessing the welfare implications of current equine management and housing practices

3.1. WELFARE, HEALTH AND SUFFERING

Welfare is not a simple physical characteristic that can be easily quantified, but efforts can be made to assess it as objectively as possible. Historically, concern for the welfare of captive animals has focused on meeting the physical requirements of the organism, such as the need to provide a balanced diet and prevent physical illness (Harrison 1964). However, if it is accepted that animals can suffer when such needs are not met, (*i.e.* at times of physical stress) then it is accepted that animals are not automatons but have some degree of awareness. If this awareness extends to an awareness of the environment, it follows that animals may suffer as a result of environmental stressors, many of which have no physical effect on the animal (psychological stress). There are many ways in which the management of

horses might raise such concerns. Stabled horses are often deprived of the opportunity to interact fully with the environment (*e.g.* through confinement and isolation) and they are often unable to apply the mechanisms, which have evolved for the regulation of normal ongoing activity (see Figure 1). An example of this is where the provision of the animal's maintenance requirements is by unnatural means, such as the provision of nutrients in the diet, in a concentrated form.

3.2. THE FIVE FREEDOMS

One way of assessing the diverse threats to an individual's well-being is embodied in the Farm Animal Welfare Council's 'Five Freedoms' (FAWC 1992). This suggests that all domestic animals should have:

- Freedom from hunger, thirst and malnutrition;
- Freedom from physical and thermal discomfort;
- Freedom from pain, injury and disease;
- Freedom from fear and distress;
- Freedom to express most normal patterns of behaviour.

Different forms of housing and management impact on each of these measures of welfare, and optimal practice is further obscured when we recognise that there are specific psychological dimensions to each measure. Scientific investigation helps to identify genuine areas of potential concern, rather than the popular anthropocentric welfare priorities. This point is illustrated further with respect to each 'freedom' below.

3.2.1. *Freedom from hunger, thirst and malnutrition*

The provision of a balanced and nutritious diet together with ad libitum water may be essential but is not sufficient to meet this freedom. Meal feeding (as experienced by intensively managed horses) is not the evolved method of ingestive behaviour and so its imposition may pose problems for the domestic horse (Mills 1999). Ralston *et al.* (1979) noted that horses do not voluntarily starve themselves for more than 4 hours and Krzak *et al.* (1991) found that wood chewing tended to occur predominantly at night when horses were likely to have empty stomachs. It seems likely therefore that the evolved mechanisms designed to regulate intake, may not be appropriate to restrictive feeding practices. Ad libitum feeding rather than more frequent meals would appear to be preferable since McGreevy *et al.* (1995) found that the provision of forage more than three times a day was associated with a greater risk of problem behaviours than less frequent feeding.

Less dominant individuals in group housing management systems may also be at a disadvantage to more dominant individuals in terms of gaining access to feed and water. Multiple feed and water troughs will help to avoid this problem.

Malnutrition not only refers to an inadequate supply of nutrients but also the provision of nutrients in a form that may cause harm. Concentrate feeding may meet an animal's chemical nutrient requirements, but the use of concentrate to increase the energy density of ingested food may not be good for a horse's well-being. Concen-

trates are associated with an increase in gastro-intestinal acidity (Rowe *et al.*, 1994, Johnson *et al.*, 1998) which may predispose animals to gastric ulceration (Murray *et al.*, 1996; Pagan 1997), wood chewing and crib-biting (Johnson *et al.*, 1998).

The provision of ad libitum water may also not guarantee freedom from thirst, since Welford *et al.* (1999) found that a shift in the timing of the normal management schedule of Thoroughbreds resulted in a drop in daily water intake of over 7% on average. Owners should be aware that changes in management may result in disturbances to behaviour which might be of concern.

The subject of nutrition and welfare is discussed further in Chapter 3.

3.2.2. *Freedom from physical and thermal discomfort*

Complex problems arise with the provision of physical and thermal comfort, since horses have been shown to exert bedding preferences in experimental situations which may be a risk to their physical health (Mills *et al.*, 2000). Mills *et al.* (2000) found that straw bedding was preferred over wood shavings and both of these were preferred to shredded paper. Whilst straw bedding is associated with fewer behaviours of welfare concern (McGreevy *et al.*, 1995), it is also associated with an increased risk of respiratory disease.

Horses do not require warm housing and maintaining adequate ventilation is almost certainly more important than maintaining a higher ambient temperature. With acclimatisation, adult horses have been shown to be able to comfortably tolerate temperatures as low as -10°C (McBride *et al.*, 1983) and even 2-day old foals may tolerate temperatures as low as 5°C as long as they are well fed (Clarke 1987). Quartz halogen radiant heaters offer a practical source of extra heat where it is required for foals.

Good ventilation should keep the housing environment free of damp and should not generate drafts. Concern over the risk of chilling is sometimes expressed for horses, which have had their coats clipped for winter. This is done to reduce sweating up during physical work and consequently the risk of chilling when this stops, in addition to making cleaning less laborious at a time when the horse's coat may be more prone to soiling. For these individuals it is preferable to use rugs and extra layers of blankets, rather than reduce ventilation of the stable to maintain thermal comfort. Thermally efficient materials are also increasingly being used for horse rugs (Clarke 1994).

3.2.3. *Freedom from pain, injury and disease*

This implies the need for safe, secure well-constructed housing, without dangerous fittings etc. However, as already mentioned, bedding substrates preferred by the horse may not be preferred by the owner, because of the risk of respiratory disease or the need to manage such a problem.

Individual housing may be preferable in terms of reducing the risk of injury between horses in an unstable group, but this should be balanced against any need for social contact. It is often thought that more restrictive housing such as tie stalls may predispose horses to tendon injuries, but the authors are not aware of any scientific data to support this supposition.

3.2.4. *Freedom from fear and distress*

The barrier associated with enclosure and captivity may result in some problems with this freedom for an animal adapted to living in expansive open areas, with flight as the main mechanism for defence. Where animals are group housed the barrier may not allow an individual to withdraw to a safe distance from a conflict situation and result in individuals which live in fear of aggression. In individual housing systems distress may result from the greater level of confinement and social frustration. Chronic frustration may cause a psychological reaction in the form of stereotypic behaviour (see Chapter 5) and possibly increase aggression as well. Stereotypic behaviours are repetitive, relatively invariable behaviours with no obvious function from the context in which they are performed (Mason 1991). They include behaviours such as weaving, box walking, cribbing and windsucking in the horse, which are relatively common in captivity with reported prevalences of up to 8.3% for crib-biting, 9.5% for weaving and 7.3% for box-walking (Nicol 1999). They have not been reported in animals which have always been free-roaming. Several housing factors have been associated with an increased risk of stereotypy including: reduced social contact, systems with less than 75 horses and the absence of a paddock (McGreevy *et al.*, 1995). Luescher *et al.* (1998) also found that weaving is more common in yards with a smaller proportion of standing stalls.

Many owners find these behaviours aesthetically unacceptable and try to prevent them from being performed if they occur in an individual (McBride & Long 2001). However, it is likely that these behaviours are highly motivated and an expression or consequence of distress rather than a cause of distress to the horse. Therefore their physical prevention, such as through the elimination of cribbing surfaces and management aids such as cribbing collars and antiweaving bars may increase suffering (McGreevy & Nicol 1998; McBride & Cuddeford 2001).

3.2.5. *Freedom to express most normal patterns of behaviour*

Providing freedom to express most normal patterns of behaviour can be particularly problematic, not least because the term normal has several meanings, none of which necessarily relate directly to welfare (Cooper & Mills 1997). Behaviour may be considered normal in a natural sense, because it is found in the normal wild population, in a statistical sense because it is relatively common among domestic horses; normal in a functional sense because it is adaptive or optimal; and normal in a social sense because it is culturally acceptable. There are clearly some behaviours which the wild horse expresses which are not desirable for good welfare in the domestic animal such as those associated with predator avoidance; and so 'normal pattern' should not be equated with 'natural range'. Rather, it is important that the naturally evolved mechanisms for regulating the natural range of behaviours are not put under strain by the domestic situation, due to environmental deprivation and frustration. It is therefore essential that the organisation and motivation of behaviour is understood. As we have already seen there is more than the physical requirements for survival to be met for good welfare.

The term 'normal pattern' may also be used to reflect the structure of a specific functional behaviour, *i.e.* the way in which the goal of a behaviour is achieved.

Deviation from the normal evolved state may also (but not necessarily always) result in welfare problems. For example, feeding forage may be a substitute for some of the problems associated with feeding concentrate discussed above, but the way it is fed (*i.e.* from a hay net) may have welfare implications which can be overlooked quite easily. Feeding from a hay net reduces wastage and eases management, but the posture is abnormal, and the additional time spent with the head raised may compromise the function of the mucociliary escalator of the upper respiratory tract (Racklyeft & Love 1990). This structure is an important part of the body's defence against disease, trapping potential disease causing particles before they can cause a problem. Thus feeding from a hay net may also predispose an individual to respiratory infection.

The time that a behaviour occupies may also be considered a part of its 'normal pattern' and may be cause for concern, as we have already seen. By way of further example, not only may housing type, but also bedding substrate may affect the time spent lying down or asleep. Outside certain functional limits, this may predispose an individual to both physical and psychological illness (Mills *et al.*, 2000). Further, the feeding of concentrates allows a horse to achieve its nutrient intake in an abnormally short time compared to the wild state. It has been estimated that a wild horse would normally chew around 57,600 times in a day (Cuddeford 1999) and the production of saliva is linked to the process of chewing, rather than presence of food related stimuli (Alexander & Hickson 1970). Saliva not only helps to lubricate the food and aid swallowing, but is also alkaline and may therefore be an important buffer against increases in gastro-intestinal acidity, such as that which occurs with concentrate feeding (Nicol 1999) or more generally help regulate gastro-intestinal pH. Therefore not only may the chemical composition of concentrates affect gut pH directly, but also the reduction which they cause in time spent chewing may deprive the animal of one of its main mechanisms for regulating gut acidity during the digestive and absorption processes. Ulceration may be one of the obvious physical welfare problems which arise as a result, whilst cribbing and woodchewing may be behavioural expressions of an attempt to compensate. This is discussed further in Chapters 3 and 5.

In summary, if the horse is expected to behave in an unnatural way, it is important to pause and consider what the implications of this may be for the horse's welfare, rather than simply assume that because the horse still functions it can adapt without compromising its well-being.

Further scientific investigation is undoubtedly necessary to quantify these problems further, but in the final analysis, an ethical judgement must be made about what is an acceptable level of risk or compromise, if horses are to be kept in captivity. In the next two sections we consider the nature of the major risks to physical and psychological health posed by captive housing and management.

4. Reducing Risk to Physical Health

Respiratory health is the major physical health concern for the stabled horse. Respiratory diseases can be categorised as being either acute or chronic and can occur in degrees ranging from life threatening, *e.g. Rhodococcus equi pneumonia* in foals, to very mild degrees of covert small airways disease, which is only manifest as a loss of performance when the horse is under extreme exertion. These mild degrees of airway disease in early life may be the precursor of the more debilitating disease COPD in later life. Special attention must also be given to design features which decrease the risk of physical injuries (Clarke 1994). One condition that should be highlighted for breeding farms is sesamoid fractures in young foals. This is the major preventable fracture that foals suffer and can have consequences for the foal's future life. This occurs when young or immature foals run to exhaustion. The incidence of this problem can be decreased by ensuring that mares and foals at risk are kept in smaller paddocks until the foal strengthens up. It is also important to avoid placing younger, weaker foals and their mothers in groups with older stronger foals which are capable of more exercise.

4.1. INFECTIOUS AND PARASITIC RESPIRATORY DISEASE

Horses are prone to a wide range of respiratory tract infections including viruses, bacteria and mycoplasmas. A review of these agents is beyond the scope of this chapter (Cullinane 1997). Careful monitoring of horses for early signs of infections, such as daily taking of temperatures and the early instigation of veterinary treatment, is critical in lessening the impact of infections. Rigid adherence to a vaccination programme is also critical. While isolation and quarantine practices can be of benefit in some situations, *e.g.* the separation of young stock and brood mares, this approach is not always practical or productive, especially in stables where horses are regularly travelling to events and competitions.

Environmental control alone is unlikely to limit the spread of a highly contagious respiratory disease in a susceptible population of horses. This is especially the case where the horses are the primary sources of the pathogens and where these infectious agents do not survive for long periods of time away from the horse. This occurs for example with an outbreak of influenza virus or herpes virus infection (Clarke 1987). This situation is further complicated with diseases such as Equine Herpes Virus infections and Strangles where there can be asymptomatic carrier horses which intermittently shed the infectious agents. However, while the air quality of the stables may not affect the incidence of these diseases it can affect both the duration and the severity of disease in individual horses. Paying attention to the air quality of the stables will result in horses getting better quicker and decrease the loss of training and competition days.

Environmental control of infectious and parasitic respiratory disease can be very successful where the agents survive and sometimes even proliferate outside of the host. *Rhodococcus equi pneumonia* is a clear example (Wilson 1997). *Rhodococcus equi* is an actinomyete which proliferates in equine faeces in warm weather and

becomes airborne to be inhaled by foals in dry dusty conditions in both paddocks and to a lesser extent in barns. Removal of faeces from paddocks and barns and damping down dusty areas in paddocks or avoiding such areas with foals will decrease the incidence of this disease in endemic areas.

Lung worm (*Dictyocaulus arnfieldi*) is well recognised for causing respiratory disease in horses. Migrating larvae of other parasites including *Parascaris equorum* and *Strongyloides westeri* can also cause respiratory disease especially in young horses. The control of parasites in horses requires careful pasture management and the regular use (and notation) of appropriate anthelmintics (Bailey 1992). The eggs and larval stages of most equine parasites are long-lived and resistant to desiccation. In relation to stable management, droppings should be regularly and thoroughly removed and deep litter management avoided.

4.2. INFLAMMATORY AIRWAY DISEASE

It is the horse's small airways, the bronchioles, which are most affected by the stable environment (Raymond & Clarke 1997). COPD is the best known manifestation of small airway disease in horses. Symptoms of COPD include chronic cough, flared nostrils, forced abdominal breathing and severe exercise intolerance. Inflammation, increased mucus production and bronchospasm brought on by a full-blown allergic reaction to inhaled mould spores cause these clinical signs. At the other end of the scale there is covert lower airway disease known as Lower Respiratory Tract Inflammation (LRTI) or Small Airway Disease (SAD). This is also an inflammatory process but not believed to be a full-blown allergic reaction as seen in COPD. There may not be overt manifestation of LRTI other than a loss of performance in equine athletes. Diagnosis of LRTI often requires veterinary endoscopic examination and an analysis of mucus samples collected directly from the horse's airways.

In this section emphasis will be placed on providing practical management approaches and building design criteria to help prevent and alleviate overt and covert manifestations of small airway disease.

The successful environmental control of respiratory disease necessitates that the horse's exposure to the pathogens be kept below the Threshold Limiting Value (TLV) which will induce disease (Clarke 1993). Unfortunately the TLV for horses to stable dust such as mould spores or noxious gases such as ammonia is unknown. Furthermore the TLV can vary both within and between individuals. For example the TLV for inhaled dust will be greatly decreased in a horse which is suffering from a viral respiratory tract infection and has damaged cilia in its airways. The cilia work to clear inhaled dust from the lungs and when the cilia are damaged there can be the equivalent of accumulation of inhaled particles for the lungs to deal with. This increase of particles retained in the lung as a result of infection is believed to explain, in part at least, why animals (including humans) are prone to develop lung allergies after a bout of infectious disease.

The best management approach in relation to LRTI is to minimise the horse's exposure to airborne contaminants at all times. This necessitates that both the sources of airborne contaminants including the feed and bedding and the processes

regulating their removal, primarily ventilation, be focused on. It is also critical to focus on the horse's breathing zone and the challenge posed at this level. For example a particles-counter or ammonia detection kit held five feet above a straw bedding in a well-ventilated stable may give a low-test result. However, high levels of dust and ammonia could be inhaled when the horse nuzzles into its bedding. This point has been reflected in recent years in research with a move away from static air samplers to units, which can be clipped onto the horse's head collar. These latter units provide data, which is collected from the horse's 'breathing zone'.

4.3. FEED

Equine nutrition is covered in more detail in Chapter 3, however it is worth noting that many of the welfare problems that are associated with the housing of horses, are related to the feeding types and methods that are used. Hay is the most common source of respirable dust and mould spores that horses are exposed to. The primary factor, which affects the mould spore content of hay (and straw), is the moisture content at baling. Hay and straw that are baled with a high moisture content undergo heating in the first month after baling. During this process there are several species of fungi and actinomycetes, which develop. These species produce large numbers of spores less than five microns in diameter, which are capable of being inhaled to the deepest levels of the lungs. Eventually horses develop an allergic response to these spores which is manifest as COPD. However, these spores can also induce non-allergic inflammation of the airways in young horses. This is a separate condition from COPD. COPD is a rare condition in temperate regions such as Australia and parts of the USA. One of the main reasons for this is that hay and straw are more likely to be baled at a lower moisture content in Australia and there is less mould contamination in these source materials. Laboratory based tests are available to assess the moulding of hay and straw. This is important because the eye and the nose are not good judges of the levels of mould contamination (Raymond *et al.*, 1997).

The soaking of hay is a well established method of minimising a horses exposure to mould spores. It is essential that the hay is wet throughout as small dry pockets can still lead to significant challenges of dust. There is also some evidence that soaking of hay for more than half an hour can lead to the leeching of water soluble vitamins and other nutrients. Also while soaking of hay will decrease the inhalation of spores it is possible that significant levels of mycotoxins could be ingested by the horse (Raymond *et al.*, 2000). Mycotoxins are metabolites produced by moulds and can have a wide range of effects ranging from decreased reproductive efficiency to nervous system damage. Soaking of hay is also labour intensive and is not practical in colder climates such as a Canadian winter.

There is a range of products, which are alternative sources of forage for horses. These include specially produced mechanically dried hay, chopped moistened complete diets, silage type products and hay cubes. Research has shown that horses eating all of these products inhale less dust than when eating traditionally produced hay.

One way of producing hay which does not ferment (or 'heat') is to mechanically dry the hay to a moisture content of less than 10% before it is baled. There are two approaches to this process. In both situations the grass is generally cut and allowed to dry in the field for between 12 to 24 hours. Following this initial drying period it is picked up loose in the field and taken to either a high temperature dryer where it is dried and baled in the one process or alternatively taken to large barns and loosely stacked with air blown through the grass to dry it before it is baled. Both of these approaches produce a premium product, which is more costly than traditionally produced hay because of equipment costs, the extra handling and energy costs. Acid based additives have also been promoted to prevent the moulding of hay (Clarke 1994). These are applied as the hay is baled. However, the success of the agents can be limited and they can also affect palatability of hay.

Haylage and large bale silage have widespread usage in the United Kingdom and their use is spreading into North America (Raymond *et al.*, 1997). Haylage and silage are baled with a higher moisture content and then sealed in airtight plastic bags. A fermentation response occurs just after baling and the associated increase in acidity inhibits the development of moulds and bacteria. The primary distinction between haylage and silage is the maturity of the grass or legume when it is cut.

Young grasses tend to be conserved as big bale silage and some horses can have loose dropping when fed this product. Some owners do not find this acceptable. Haylage tends to be prepared in small bales and more mature grasses are used. The high sugar contents of mature ryegrass makes this a popular choice for haylage, especially in the United Kingdom.

Once a bale of silage or haylage is opened it should be fed within a few days. This is because moulding will develop especially in warm weather. There have been rare incidences of botulism associated with the feeding of large bale silage to horses. Any bales of silage which are punctured or which have signs of being contaminated with dirt or the remains of animals *e.g.* dead rabbits, should not be fed to horses.

Hay cubes are very popular alternatives to hay especially in North America (Raymond *et al.*, 1994). There are two basic forms of cubes. The first is produced from previously baled hay. The second is made from grass which is freshly cut and dried in the paddock for between 12 to 24 hours before being mechanically picked up and taken for drying and cubing in one process. The quality of hay cubes used in the former process is dependent on the quality of hay used. The latter process is beneficial in that there is a decreased risk of mycotoxin for horses. Lucerne is the most common commodity used for hay cubes, however, there are lower energy varieties with grasses as well as higher energy products which incorporate maize with lucerne. The latter is popular for performance horses.

All of the forage alternatives described above expose horses to lower dust and respirable mould spores than dry hay. There can be significant differences in the cost-effectiveness of these products based on a dry-matter basis. From a behavioural point of view hay cubes and haylage products can be eaten a lot quicker than hay, which can lead to problems with stereotypical behaviour. This can be

avoided by forcing the horse to take extra time eating its forage. One way of achieving this is feeding haylage in a hay net with small holes.

4.4. BEDDING

Bedding is the second major source of respirable mould spores in the stable. The level of mould contamination varies greatly between different batches of straw. As with hay the moisture content at baling is the key factor which influences the level of moulding in the straw and the level of exposure the horses face. However, even the cleanest of straw contains significantly more respirable spores than alternatives such as wood shavings, paper, sawdust, peat or synthetic products. Significant levels of mould contamination can occur in wood shaving, which are produced with high moisture levels or exposed to the elements. A common sign of moulding in wood shavings in plastic bags can be grey streaks through the products.

Bedding horses on alternatives to straw does not ensure that the bedding is not a significant source of mould spores or other pathogens. Very high levels of airborne respirable spores can emanate from bedding materials, which are managed in a deep litter approach, and also in stables which are poorly ventilated. While different species of moulds tend to develop on wood shavings compared with straw, these species still produce large numbers of tiny spores, which can reach the horse's small airways.

At the end of the day using alternatives to straw such as paper or wood shavings will improve the respiratory health of horses. However, care must be taken to ensure that moulds do not grow in sites and that ammonia levels do not build up.

4.5. AMMONIA

Ammonia is the most common noxious gas to which horses are exposed (Curtis *et al.*, 1996). It is released by the action of bacteria on horse's urine and faeces on the floor of the stable. Ammonia damages the mucociliary escalator and increases mucus production. Feeding of high levels of protein can increase ammonia production in a stable but there is considerable individual variation in this context. Ammonia levels increase in poorly ventilated barns especially where drainage is poor and deep litter management is practical. Ammonia levels also generally increase with increasing temperatures and humidities. Methods, which decrease ammonia levels in stables, include:

- Improving drainage;
- Ensuring adequate ventilation;
- Frequent removal of excreta and wet bedding;
- The use of commercially available ammonia control products.

4.6. VENTILATION

A well ventilated stable will help to decrease the horse's exposure to a wide range of pathogens including; noxious gases, dusts and microbes (Clarke 1994).

Ventilation can also be used to aid in decreasing the risk of moulding of plant-based bedding materials. However, ventilation cannot be used to overcome inherent management problems. For example, a horse can still inhale significant levels of spores from mouldy hays or bedding in a well ventilated stable.

4.6.1. *Natural forces of ventilation*

The majority of horse stables and barns can be ventilated effectively without the use of mechanical support.

There are three natural forces of ventilation:

- i) The stack effect. This occurs as a result of warm air rising. The heat generated from horses can be harnessed to capitalise on this effect.
- ii) Aspiration. Wind blowing across a roof of a building will suck air out of the building.
- iii) Perflation. Air movement associated with wind blowing from end to end or side to side of a building. In exposed locations this natural force of ventilation can lead to drafts and must be compensated for with the strategic location of window, vents and draft dampers.

The ventilation of a building is most tested in still air conditions when the only driving force is warm air rising off the horses. Thus, stables should be designed on the assumption that windless conditions prevail. The relationship between levels of airborne contaminants and ventilation is curvilinear with the concentration of airborne contaminants being directly related to the reciprocal of the ventilation (see Clarke 1987). Thus the concentration of airborne contaminants increases sharply at low ventilation. Equally, doubling the air change rate at higher levels of ventilation is not associated with a halving of the airborne contaminants. In considering the principles of natural ventilation in still air conditions a target of four air changes per hour with the top door of the loose box or the main doors of a barn closed should ensure adequate ventilation all year round.

The principles that govern the natural ventilation of livestock housing have been described by Bruce (1978) and reviewed by Clarke (1987). The key elements to consider include:

- The stocking density and the heat production
- Insulation
- The height between the inlet for fresh air and the outlet for warm air
- The size of the inlets and outlets

The following guidelines (see Table 1) are provided for 'typical' loose boxes or barns based on the requirement for 4 air changes per hour.

The main advantage of having an insulated barn is that it decreases the size of the openings necessary to effectively ventilate the barn. Insulating the building will also decrease the risk of condensation.

Consideration must be given to the distribution of the inlets and outlets in stables. For individual loose boxes with a monopitched roof there should be one opening in the front and one in the back. There should be an additional outlet in the form

Table 1. Requirements for adequate ventilation of insulated and uninsulated horse housing.

	Insulated		Uninsulated	
	Loose box	Barn	Loose box	Barn
Dimensions per horse (m ³)	50	85	50	85
Height between inlet and outlet (m)	1	1	1	1
Required inlet area/horse (m ²)	0.27	0.38	0.34	0.46
Required outlet area/horse (m ²)	0.14	0.19	0.17	0.23

of a chimney or covered ridge for stalls or barns with peaked roofs. Baffling can be used to decrease draughts or the entrance of rain or snow into vents on exposed walls. A more widespread distribution of vents is required for large barns. Large areas of Yorkshire boarding, capped ridges and 'breathing roofs' can also be very valuable in ensuring adequate ventilation and mixing of air in barns.

5. Reducing Risk to Psychological Health

The welfare of a subject relates to its subjective experience given the range of challenges it faces at any given time. A number of cross-sectional epidemiological studies have identified risk factors associated with threats to psychological well-being which may result in stereotypic behaviour (see Nicol 1999 for a review). These studies identify associations but cannot identify causal links. Thus the finding that horses that weave are more commonly associated with housing that allows minimal social contact does not prove that lack of social contact is a cause of this problem. Although there is no scientific support for the supposition that weaving can be copied by horses, many owners feel that this is the case (McBride & Long 2001) and so horses with this problem may be placed in more isolated positions because of their behaviour. This would result in the same finding. Other housing and management factors which have been associated with an increased risk of welfare problems have been mentioned earlier (see also Chapter 5). So in this section we will focus on the level of isolation and on feeding practice. Whilst confinement (restriction of movement) is commonly thought to be a major concern, the scientific evidence for this is still weak; this will be discussed in the latter part of this section.

5.1. ISOLATION

Isolation is a restriction on interaction with the environment. The issue of whether or not animals have a need to express certain behaviours in the absence of any stimulus for the behaviour remains controversial, but there is evidence to suggest that social isolation is stressful for the horse (Mal *et al.*, 1991; Jezierski 1992). This has adaptive value since social tendencies are an advantageous species-specific trait

for the horse (Mills & Nankervis 1999). Selection would then favour any mechanism, which motivates effort to establish social contact when isolated. In this case, we hypothesise that the horse housed in social isolation is in a chronic state of frustration, which might be alleviated by social contact. Interestingly, Cooper *et al.* (2000) found that weaving in horses was significantly reduced when they had access to a conspecific in an adjacent stable through a grilled 1 m² portal. This effect has been replicated with the use of a similar sized mirror (Mills & Davenport 2002) and in a longer term study, McAfee *et al.* (in press) found that this sort of mirror also reduced aggressive threatening behaviour over the stable door. This change is also consistent with the hypothesis since chronic frustration from a signalled reward is often expressed in terms of increased aggression (Rolls 1990). There is therefore a strong case for the provision of social or 'pseudo-social' housing. The one situation in which isolation can be beneficial is for the foaling mare, since even in the natural state the mare separates from the rest of the herd at this time (Tyler 1972). Isolation at this time may also reduce the risk of problems with the development of the sequence of motor patterns that are required for successful suckling by the foal (Mills & Nankervis 1999).

5.2. FEEDING PRACTICE

This describes what is fed and how it is delivered. Some of these issues have already been discussed earlier in this chapter, especially the problems associated with the feeding of concentrate. Recent unpublished studies on nearly 60 horses by Mills suggest that the regular inclusion of antacids in the diet may significantly reduce cribbing behaviour. Other strategies for reducing the risk of pH disturbance from concentrate feed include the encouragement of mastication and hence increased saliva flow through the provision of more forage, forage in nets with smaller holes to reduce the rate of intake, and compacted forage sticks which increase the time spent in the prehension phase of ingestion. Meeting the energy requirements of the diet through fat rather than carbohydrate might also be expected to produce a more stable and less acidic gastro-intestinal environment. All of these strategies appear at least anecdotally to reduce cribbing, windsucking and many cases of wood-chewing. Marsden (1999) also reports that there is an exponential inverse relationship between the proportion of time spent feeding and the proportion of time spent engaged in a range of abnormal behaviours.

The presentation of food, especially concentrate, represents a rewarding event and many horses appear to exhibit bizarre feed time rituals which have probably been conditioned through the presentation of feed. This is also a time of high arousal as food is anticipated and so frequent meal feeding or staggered feed-times across a yard may be expected to increase the stress load on a horse. The provision of an ad libitum forage based diet is therefore to be preferred when possible. Foraging devices which require the horse to work for a small amount of concentrate at any given time have been proposed for the prevention of some of these problems, but have a variable effect (Henderson & Waran 2001). They may moderate the period of high arousal associated with the delivery of food and so be efficacious for the

control of pre-feeding problems, but the substantially extended time spent involved in ingesting concentrate (Winskill *et al.*, 1996) may exacerbate problems related to this component of the diet. It is popularly suggested that 'toys' help to alleviate boredom, but there is neither any evidence that horses can feel bored nor any identifiable problem which can be reliably associated with this state of mind since the evidence suggest that most stable 'vices' appear to be related to specific frustrations.

Management regimes may also be associated with an increased risk of problems such as colic, which obviously have a serious impact on the welfare of the horse. Practices which may help in the prevention of colic and which help to improve welfare in other ways include the following:

- Avoid sudden or large changes to the daily routine – including feeding and exercise.
- Feed a high quality diet comprised primarily of roughage where possible.
- Avoid feeding excessive grain and energy dense supplements. (At least half the horse's energy requirements should be supplied through hay or forage. A better guide is that twice as much energy should be supplied from roughage source than from concentrates.
- Divide daily concentrate ration into two or more smaller feedings, rather than one large one, to avoid overloading the horse's digestive tract. Hay is best fed free-choice.
- Set up a regular parasite control program with the help of your equine practitioner. Utilise fecal testing to determine its effectiveness.
- Provide exercise and/or turnout on a daily basis.
- Change the intensity/duration of an exercise regime gradually.
- Provide fresh, clean water at all times. (The only exception is when a horse is excessively hot. Then it should be given small sips of lukewarm water until recovered.)
- Avoid medications unless they are prescribed by your equine practitioner, especially pain-relief drugs (analgesics), which can cause ulcers.
- Check hay, bedding, pasture and environments for potentially toxic substances such as noxious weeds, and other indigestible foreign matter such as hay binding.
- Avoid putting feed on ground, especially in sandy soils.
- Make dietary and other management changes as gradually as possible.
- Reduce stress. Horses experiencing changes in environment or workloads are at a high risk of intestinal dysfunction.
- Pay special attention to animals when transporting them or changing their surroundings, such as at shows.
- Observe foaling mares pre- and postpartum for any signs of colic. Also watch any horses who have had a previous bout with colic.
- Maintain accurate records of management, feeding practices, and health.

5.3. OTHER REQUIREMENTS

No work has yet been published which has quantified the psychological needs of the horse. However, there have been a number of behavioural studies, which suggest the preferred requirements of horses. The interpretation of preference tests in terms of welfare is not simple since preference for one substrate over another does not imply that either is necessarily associated with suffering nor may either be good for the subject's well-being.

In addition to the bedding preferences of horse already discussed (Mills *et al.*, 2000), horses have been found to prefer a lit to a dark box stall (Haupt & Haupt 1988) and will work for access to a paddock (Haupt, personal communication). Exercise is also associated with a reduction in wood chewing (Krzak *et al.*, 1991) and possibly other behaviours of concern. Kusunose *et al.* (1985, 1987) found that yearling horses were restricted in their canter in fields of 1.5 ha but not in fields of more than 2.1 ha and that the shape of the field also affected behaviour. In the latter study (Kusunose *et al.*, 1987) suggested on the basis of the type of movement shown, that square paddocks are preferable to those proportioned 1:2 or 1:4. Whilst the limitations of these studies are accepted, it does no harm to recognise and implement their recommendations where possible, given the relative paucity of scientific knowledge available to guide decisions. At present we can only hope to adopt best practice on the basis of the areas so far recommended and careful consideration of the biological nature and expected limitations of the horse.

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