Veterinary management of horse transport

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Summary

Enormous numbers of horses are transported locally, nationally and internationally every year. National legislation and international guidelines set standards for the health and welfare of animals during transport. As a consequence, equine clinicians have major responsibilities in safeguarding the horse industry against the spread of disease and in being aware of the problems inherent in horse transport. The authors explore road, sea and air transport and their effect on horses. Various types of road transport are available and there are various sources of impact on horses. These include loading, the effect of confinement and isolation, restraint within vehicles, motion of vehicles, environmental challenges within vehicles, food and water intake, body posture during transport and orientation within the vehicle. Air transport has prominence and an account is given of the special management required for horses during air transport over long distances. Finally, the effects of transport on illness and performance are outlined. Shipping fever is discussed.

Keywords

Air transport, Animal, Disease, Horse, Road transport, Transportation, Welfare.

Gestione veterinaria nel trasporto di cavalli

Riassunto

E' altissimo il numero di cavalli che vengono spostati ogni anno a livello locale, nazionale ed internazionale. La legislazione nazionale e le linee guida elaborate a livello internazionale fissano degli standards per tutelare la salute e il benessere degli animali durante il trasporto. Di conseguenza , i veterinari che si occupano di cavalli hanno grandi responsabilità per quanto riguarda il controllo della diffusione di epidemie e la corretta gestione dei problemi inerenti il trasporto di equini. Gli autori prendono in esame il trasporto su strada, via mare ed aereo e i conseguenti effetti sui cavalli. Ci sono diverse tipologie di trasporto su strada e di conseguenza diverso è l'impatto che hanno sui cavalli. Queste includono la fase di carico, gli effetti del confinamento e dell'isolamento, la costrizione, il moto del veicolo, le problematiche ambientali interne al veicolo, l'apporto di acqua e cibo, nonché la postura durante il viaggio e il posizionamento all'interno del veicolo. Il trasporto per via aerea presenta aspetti particolari ed è necessario prestare grande attenzione alla peculiare gestione dei cavalli che esso richiede, in particolare per lunghe distanze. Infine vengono descritti gli effetti del trasporto sulle patologie e sulle performance. Si discute sulla "shipping fever".

Parole chiave

Animale, Benessere, Cavallo, Patologia, Trasporto, Trasporto aereo, Trasporto su strada.

Introduction

Horses are culturally important animals. Some have a very high monetary value and are transported worldwide for breeding, competition and sporting events. Modern rapid transport of horses raises a set of unique considerations that did not previously exist. These considerations are explored in the present paper, which provides a picture of the

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challenges and the care of horses required to meet these challenges. The paper emphasises the national and international responsibilities of veterinary clinicians in relation to transport.

Background

An enormous number of horses are transported locally, nationally and internationally. Export and import movements have been recorded but, until recently, only to and from countries outside the European Union (EU). The number of horses transported and the number of times that each horse is transported within EU member states has therefore been impossible to quantify. Recording of movements becomes very important when investigating the spread of disease. However, recording of horse movements now forms part of the new EU Trade Control and Expert System (TRACES system) (17). TRACES is an electronic system which replaced the animal movement (ANIMO) control system in 2004. It is used to exchange information on intra-Community trade, importation or transit in the EU of live animals, semen and embryos, as well as trade in mammalian animal waste and the importation of certain animal products. Furthermore, the transit of animals or animal products from a third country to another third country, imports from third countries and temporary importations are also documented. These data have become a very valuable information resource.

All movements of horses carry some risk of disease transmission. In times past, international transport of horses could only be achieved through arduous rail or sea journeys, often taking several days and sometimes leading to diseases such as 'shipping fever'. Alternatively, the journey itself became a form of quarantine period in which horses could be observed for signs of disease. Similar journeys can now be completed within hours of departure, usually by air. Quarantine and isolation have therefore become much more important. Ironically, the advent of the EU has resulted in decreased state participation in this process, which increases the onus on individuals, be they transport agents, owners, breeders, trainers or attending equine clinicians. Geographic factors are also important in the detection and isolation of equine disease. Islands, such as Ireland, New Zealand and the United Kingdom have an inherent advantage in this context over those countries that have frontiers with other member and non-member States. Expansion of the EU has created a fresh series of challenges in this context. There are significant economic advantages in raising potentially high value horses in accession countries with relatively low land purchase and labour costs that are coupled with standards of horsemanship that are increasingly difficult to access in many other countries. Inspection at EU borders (border inspections posts or 'BIPs') will remain critical, whether these are land borders or international shipping or airports. A recent example of the importance of such stringent biosecurity measures is the suspension of equine travel from Australia in order to prevent the spread of the equine influenza outbreak from Australia to New Zealand where the disease is not present. The proposed establishment of an equine reference laboratory for Europe to standardise reagents and methodologies, particularly for export/ import should therefore be warmly welcomed. This would help to resolve any disputes on exports to third countries and facilitate standardisation with our trading partners.

The World Organisation for Animal Health (*Office International des Épizooties*: OIE) lists the equine notifiable diseases (17). Equine notifiable disease outbreaks are not always caused by horse movements. The alleged importation of illegally produced equine plasma from Italy into Ireland was associated with potentially catastrophic consequences for the Irish horse industry in 2006.

Outbreaks of non-equine OIE notifiable diseases can also have profound impacts on the horse sector; for example, the recent epidemic of foot and mouth disease in the United Kingdom. Notifiable and non-notifiable diseases are all documented in the reports of the Equine Collating Centre (www.aht.org.uk/ icc/linksicc.html). Notification of disease

occurrence through the reports of the Collating Centre and every other avenue of communication is essential and was very valuable in the control of spread of the outbreak of equine influenza, which commenced in the United Kingdom in the spring of 2003. Increased vigilance is required to prevent, if possible, but essentially to diagnose conditions that are not normally seen, especially in horses that have travelled long distances. Exotic diseases have occurred post arrival even where government monitored pre-export quarantine has been enforced. The occurrence of West Nile fever in a dual hemisphere stallion in post arrival quarantine in Sydney in August 2002 emphasises the risks. High-value Thoroughbred racehorses and breeding stallions travel extensively. A significant number of stallions, mainly Thoroughbreds, are shuttled to the southern hemisphere after the conclusion of the northern hemisphere breeding season in July and return in December and January. A small number of stallions based in the southern hemisphere have recently begun to travel to the northern hemisphere and then return to the southern hemisphere. The total number of stallions that 'shuttle' between the hemispheres varies annually between 80 and 120 or more, as discted by local and global market forces.

The catastrophic outbreak of equine influenza in Australia that commenced in August 2007 demonstrates that literally millions of dollars can be lost on a daily basis when an exotic disease is imported. Diagnosis is not always easy, especially where the differential diagnosis must include the possibility of shipping fever, either alone or in combination. It is clear however, that national and international transportation of horses and their biological products are a clear and ever present danger to equine health status.

Safeguarding the horse industry against the dangers of the spread of disease is one of the major responsibilities of the equine clinician. Clinicians also need to be aware of the problems inherent in horse transport and the ways in which these problems are manifested.

Historical aspects

The transportation of horses has a long history. It is claimed that as early as 480 BC, Xerxes moved his entire cavalry by ship across the Hellespont against the Ancient Greeks. Hannibal is recorded as having used rafts to get his horses across the Rhone in 218 BC and, in the 14th century, a two-way trade in horses grew between Britain and the European continent. For the most part, the reasons for transporting horses were linked with their use by the military and enormous numbers of horses were transported by sea from the United States, Canada and South America for use in the Boer and Crimean Wars and in World War I. Rail transport was previously used for racehorses and for yearlings destined for sale in Ireland and the United Kingdom and, although much less popular than road transport, this form of land transport is still in use in continental Europe and, in the experience of the first author, in India. Today, the majority of horses are transported either by road or by air.

European legislation and international guidelines on transport

Transport and animal welfare are closely linked and are of increasing importance to the public worldwide. Different international organisations are working on issues of animal welfare during transport, including the EU, the Council of Europe and the OIE. The European Food Safety Authority (EFSA) is the keystone of EU risk assessment regarding food and feed safety and provides independent scientific advice and recommendations. The International Air Transport Association (IATA) provides guidelines for the transport of horses by air. While recommendation and standards of the European Council, the OIE, EFSA and IATA are not legally binding, the EU regulations are.

European Union

The Council regulation of the European Community (EC) No. 1/2005 sets standards on the protection of animals during transport and related operations (11).

European Food Safety Authority

One of EFSA's panels is the Animal Health, Animal Welfare Panel (AHAW panel) which provides independent scientific advice on all aspects of animal diseases and animal welfare. On a request from the European Commission related to the welfare of animals during transport, the AHAW panel provided a scientific opinion in 2004 (10).

Council of Europe

The conventions on the protection of animals elaborated at the Council of Europe were the first international legal instruments laying down ethical principles for the transport, farming and slaughter of animals, as well as for their use for experimental purposes and as pets. They have been used as a basis for and continue to influence all the relevant legislation in Europe. The European Convention for the Protection of Animals during International Transport (5) lays down the general conditions for the international transport of animals from their preparation to loading and unloading, such as design of transport means, fitness to transport of the animals, veterinary controls, handling of animals, certificates, etc. and sets out special conditions for the transport of animals by road, air, sea and rail (5). Detailed recommendations on the transport of horses, pigs, cattle, sheep and goats, and poultry have been adopted by the committee of ministers of the Council of Europe. Recommendation No. R (87) 17 sets forth standards on the transport of horses.

Office International des Épizooties

Animal welfare was first identified as a priority in the OIE 2001-2005 strategic plan. OIE member countries and territories mandated the organisation to take the lead internationally on animal welfare and, as the international reference organisation for animal health, to elaborate recommendations and guidelines covering animal welfare practices, reaffirming that animal health is a key component of animal welfare. At its 73rd annual meeting in May 2005, the OIE International Committee adopted five animal welfare standards to be included in the OIE *Terrestrial animal health code* (52). These cover the following:

- the transport of animals by land
- the transport of animals by sea
- the transport of animals by air
- the slaughter of animals for human consumption
- the killing of animals for disease control purposes.

These standards are updated regularly.

ON 24 November 2006 in Strasbourg, the EU, Council of Europe and OIE agreed on a joint declaration on animal welfare in Europe. The declaration which commits to greater cooperation on all aspects of animal welfare, was adopted at an international workshop aimed at bridging the gap between animal welfare legislation and its practical application.

Globalisation of trade in animals and their biological products consequently lead to increased international movement of horses. The three officially recognised 'sisters' of the World Trade Organisation (WTO) as standard setting bodies for animals, food and plants are the OIE, Codex Alimentarius and the International Plant Protection Convention (IPPC). Trade barriers related to infectious animal diseases are covered by the WTO's Sanitary and Phytosanitary (SPS) Agreement (51) and the standard setting body for these trading issues is the OIE. Unfortuately, until today animal welfare is not part of any WTO agreement and therefore there is no reason for trading sanctions.

Road transport

General considerations

Transport can be stressful for horses. Fraser *et al.* (13) defined stress as occurring in animals that are required to make abnormal or extreme adjustments in their physiology or behaviour in order to cope with adverse effects of their

environment and management. Transported horses can experience large-scale changes in environmental temperature, relative humidity and exposure to environmental contaminants during journeys (23). They may also have to adapt to different management strategies including mixing with unfamiliar travelling companions, confinement in unfamiliar spaces, unfamiliar movements beneath their feet, climbing and descending, unfamiliar drinking water and so on. Horses used for sporting and recreational purposes that have had a number of relatively positive experiences of being loaded and transported are less likely to be adversely affected by the transportation process *per se*, than horses with no experience and horses that have had a negative previous experience, such as a fall, over-crowding etc. However, horses that may have become accustomed to transportation by road may also suffer from problems associated with frequent journeys. The pressures placed upon the frequent traveller are likely to be associated with physical demands associated with fatigue, disrupted feeding patterns, loss of weight and restricted movement. Horses transported for slaughter are more likely than other horses to be in compromised health/condition and, as such, may be expected to be more susceptible to transport-related problems (14).

Types of road transport

There are many different types of road vehicles used to transport horses. The motorised horse box or horse lorry can vary in capacity from 1 to 10, 12 or even 16 or more individually stalled or grouped horses. An alternative mode of road transport is the horse trailer (boxes or floats). There are different types of trailer and depending on use, the stock trailer will carry a large number of loose (i.e. not tied or individually stalled) horses, whereas the competition trailer is usually designed for two or more horses. The trailer has a rear and sometimes a side ramp, although in some countries (e.g. the United States), there is no ramp and the horses are trained to 'step up'. Typically, horses face towards the direction of travel, although there are now rear-face and herring-bone (diagonal facing) versions. The container is usually towed by a car or van and is attached to the towing vehicle at one point via a tow hitch (ball socket or bar), which makes them particularly susceptible to the vectoral changes acting across the hitch when on minor roads with many bends/corners. There are other designs where the trailer sits over the rear axle of the towing vehicle. These 'goose-neck' or tractor-type trailers are considered by some horse owners to be more stable for towing than the ball-hitch, bumper-pull types. It is however arguable that horses transported in trailers are more susceptible to driver ability than those in lorries or trucks. Given certin drivers or driving conditions, the trailer can start to 'sway' from side to side more and there is certainly a risk of it being over-turned whilst the horses are inside. However the well built, double horse trailer driven by a competent person is often used as a horse ambulance, as it has low slung axles which means that the loading ramp is less steep than that on a lorry/truck. In addition, any vehicle can tow the trailer in an emergency and various internal modifications (slings, padding) and external features (winch, moving floors) can be easily added.

Components of a road journey

It is generally accepted that transportation is made up of loading, restraint and confinement in the vehicle, movement and vibration of the vehicle, internal environment (design factors and physical environment), effects of food, water and rest opportunities, unloading and recovery (46).

Loading

It has been suggested that for some horses, fear of entering into an enclosed space as well as the height of the step up onto the ramp and the instability and incline of the ramp, all combine to a fear of loading (19). Ramp climbing was investigated by Waran and Cudderford (47) who reported that horses under three years of age were less willing to load (yearlings took an average of 368 seconds to load compared to three year olds at 5 seconds), showed more evasive behaviour and had higher peak heart rates than older, more experienced animals. Some horses will nose and paw at the ramp

prior to loading (16, 47). Houpt and Leib (19) suggested that all horses should be as accustomed to loading as foals. Reducing the step up onto the ramp and the ramp incline will encourage ease of loading and reversing the horse into a trailer (via a flat ramp) also induces fewer fear responses. Making the ramp more solid so that it appears more stable may also help (3) and rubber matting may help to buffer the hollow sound of a ramp when it is being used. Many States in the United States prevent the use of manually lifted ramps on the grounds of human safety and so trailers can have gates or doors that open outwards and a step up into the trailer. One advantage of the step-up trailer design is thought to be that it ensures that the horse lowers its head upon entry to the container. This protects the horse against potential damage to its head. Loading areas and ramps should always be well lit (Fig. 1). The use of sedatives to aid loading has become common practice but they must be administered before loading has started, whilst the horse is in a relaxed state but must not be given to racehorses or competition horses if it will compromise testing requirements (Fig. 2).

Figure 1
Ramps should be well lit for loading and unloading

Confinement and isolation

Horses may be instinctively afraid of confinement. Close range vision is less well developed and it is claimed that their eyes do not adapt rapidly to changes in light intensity from light to dark. Horses have good peripheral vision and therefore it is unclear where windows should be placed in vehicles.

Figure 2
Loading horses destined for the Olympic Games in Sydney

There are differing opinions on whether windows are beneficial; some believe that they can create the illusion of space (33), whilst others state that the shadows of moving cars and trees, etc., may cause a fear response. Confinement in the vehicle limits the behavioural opportunities available to the horse; in most cases they cannot turn around, move freely or, in most cases, lie down. The effects of confinement on the horse were investigated by Mal *et al.* (26) when they stabled horses with and without companions and compared their responses to those of horses at grass. Their findings confirmed that both isolation and confinement are stressful for horses.

Confinement within a specific space is usually achieved by means of partitions made of wood or metal and attached to the sides of the vehicle so that they can be moved/opened to enable the animal to be loaded and then shut in on both sides. Depending on the type of vehicle (trailer or lorry) and the internal layout, there may also be straps, bars or gates that enclose the horse's front and rear. The design of this internal furniture is crucial for the safe and comfortable carriage of the horse and yet there has been very little objective research in this area. For an average sized horse (height 158 cm, weight 550 kg), it has been suggested that a space of 90 cm wide, 2.4 m high and long should be used (19). To enclose the horse, this would require partitions to be 2.4 m in length, but the height and design is unclear. Many commercially built vehicles come equipped with partitions that are full height (i.e. are as high as the horse from the floor to the wither) and solid. There are other types of partitions that are 'half height', in that they are solid from the wither or shoulder height to the top or middle of the leg, and then open from there to the floor, sometimes with a rubber 'curtain' attached. An advantage of the half (half height) partition is that it allows the animal to 'straddle' or 'brace' (position the front and legs wide apart), whilst the vehicle is moving. However, this type of partition can also predispose to kick injuries from adjacent travelling companions.

When horses are confined within a stationary vehicle for a short time, heart rates remain quite low and similar to resting levels (38, 47), and horses appear to eat normally, stand in a 'normal' posture and sometimes rest a hind leg (47).

Restraint

In addition to the restrictive nature of the space available in a trailer or lorry, most sports/recreation horses will also be restrained within the individual stalls. Head ties are applied to prevent the horse from attempting to turn around and for ease of handling. If the horse is tied too tightly, this will prevent it from adopting the safest and most comfortable stance when the vehicle is in motion. This may lead to health problems due to the head being held too high thus negatively affecting effective draining of the upper respiratory tract (30).

Movement

The engine noise, vibration of the vehicle and the smell of the exhaust fumes will combine to provide a new challenge for the inexperienced traveller. Recorded sounds from a transport vehicle have been shown to induce the greatest increase in heart rates in pigs compared with their responses to the sounds on farm and at the abattoir (40). However, it was also shown that pigs habituate quite quickly to a consistent noise and so this may only be stressful to animals during the first stages of transport. As the vehicle begins to move, the horse has to cope with additional problems such as staying upright (balancing) and coping with the environmental challenges related to being confined inside a semi-enclosed space.

Environmental challenges

The space inside the moving vehicle is not usually conducive to a healthy environment. Good ventilation is vital to ensure acceptable air temperatures, relative humidity and levels of contaminants, such as gases and dust (32). Traub-Dargatz *et al.* (43) demonstrated that following exposure to ammonia, nitric oxide and carbon monoxide, a horse's respiratory clearance is reduced. This is due to damage to the pulmonary epithelial barrier, which then becomes more permeable to bacteria, leading to an increase in the incidence of infection. Although it seems that no upper limit for exposure to ammonia and other gases has been recommended for equids, it seems sensible to propose that this should be lower than the limit set for humans. Cregier (7) proposes that this level should be 20 ppm, based on a recommended limit of 25 ppm for humans laid down by American government hygienists. However Smith *et al.* (39) found no adverse reactions by horses transported at levels below 30 ppm. It is clear, however, that there is no safe limit for exposure to noxious agents.

Studies of air flow around and within lorries used for transporting livestock (including hens), have been performed (29, 31). Tests using model horse lorries conducted by

Leadon and colleagues (D.P. Leadon, unpublished data), provide valuable information on how airflow around a horse may operate. 'Puffs' or 'plumes' of air usually enter the horse lorry through the windows or vents along the side of the lorry; this air then drops towards the floor. At this stage, the air becomes contaminated with dust from the bedding, gases and any bacteria that might be present. The air the horse breathes is likely, therefore, to be of extremely poor quality. Additional roof vents did not appear to help matters and, of course, the situation is worse when the vehicle is stationary at which time the air becomes stagnant, as there are fewer air changes and the air quality deteriorates significantly within two hours. In trailers, there is the additional problem of the towing vehicle contributing to the poor air quality inside the trailer. Air vents are usually built into the trailer sides through which exhaust fumes are drawn.

It is clear that the potential for heat stress is great, especially when the vehicle is stationary and where there is more than one horse on board the vehicle.

Food and water intake

Depending on the reasons for transportation, horses may or may not have the opportunity to feed and drink en route. Performance horses will often be offered forage in the form of hay or 'haylage' in a net, if the owner/manager feels that this will not impair performance (Fig. 3). In general, horses accustomed to transport will 'pick' at their forage but it is likely that their intake will be reduced. Waran and Cudderford (47) found that horses in a moving vehicle fed less than when they were standing in a stationary vehicle; this suggests that the movement of the vehicle inhibits feeding. Hopes (18) stated that many racehorse trainers acknowledge that travelling has an effect on weight and fitness. In fact, when racehorses were transported by road for 6 hours and where food was offered, they still experienced an average 2.5% reduction in body weight (46). This weight was not regained until the third day after transport. Weight loss is likely to be due to a combination of reduced feed intake, reduced water intake and increased energy requirements. Foss and Lindner (12) also found that weight losses were related to distance travelled in a trailer and dehydration is a suggested explanation for the weight losses recorded in the study by Smith *et al.* (39). Reduced water intake is probably due to the horse's well documented reluctance to drink water from an unaccustomed source (27). In addition, horses are often less willing to feed and drink in unfamiliar or stressful surroundings. During transit, water should be offered whilst the vehicle is stationary (during breaks in the journey), at least every 2 to 4 hours, especially when external temperatures are high (19). In extreme circumstances, after an experimental journey of 24 h within the United States (49), 15% of horses used in the study were judged unsuitable for further transport on the basis of weakness and high body temperatures.

Figure 3
Haylage in a net for horses transported in jet stalls

Body posture and events during transport

To remain upright when the vehicle is in motion, horses must make certain postural adjustments. Cregier (7) observed that horses adopt a certain body posture when being transported. The unstable surface the horse must stand on in a moving vehicle appears to induce the horse to adopt a 'bracing' posture (47), where the hind legs and forelegs are held wide apart (splayed), the fore limbs are advanced from the usual position beneath the body (46) and at the head and neck are raised, thereby placing more weight over the hind quarters (7, 34). The elevated heart rate

associated with transport, recorded by a number of researchers is likely to be associated with the effort needed to maintain balance. This is supported by Mars *et al.* (27) who suggested that the elevated heart rates that were recorded during transportation of their horses in stock trailers were due to shifting of weight and stance to cope with highway driving. Horses can spread their fore and hind legs where the partitions within the vehicle are half height. Loss of balance and subsequent 'panic' has been described where horses were given insufficient space to adopt the 'bracing' stance (41). The road type also plays a role in determining how frequently the horse loses balance. Horses transported on minor roads, where there are more corners/bends in the road and an uneven surface, tend to lean against partitions more and show more leg movements (shifting position) than when on higher quality, faster roads, such as motorways, autobahns and freeways.

Orientation within the vehicle

Various researchers have suggested that the main problem with transportation by road is related to the way in which the horse responds to the movements and vibrations of the vehicle (7, 34, 42). Particular concern has been expressed in regard to what happens during sudden decelerations, such as braking or cornering when the horse in the forward facing position will be propelled forwards. Cregier (7) maintains that the horse is likely to be instinctively protective of its head and chest area and as such will hold its head and neck in an unnaturally high position to protect itself from injury. She also suggests that the hind quarters must continually shift and change position to counteract the changing forces imposed upon the horse when travelling in this position. Doherty *et al.* (9) reported that the rear face (backwards) position was associated with lower energy expenditure and heart rates in ponies than if they were facing the front of the vehicle or sideways, thus confirming other similar reports (4, 36, 37, 48). Horses transported facing the rear of the vehicle, against the direction of travel, showed fewer losses of balance, made contact with the sides of the lorry less, carry their head and necks lower (4) and showed a less rigid posture (34) than when they were facing the direction of travel (i.e. forward-facing). The reduction in physical effort by horses transported in the rear face direction, has been used to explain why, when horses are given the choice, they choose to position themselves facing away from the direction of travel when the vehicle is moving (38). However this does not appear to be the choice made by horses transported in the United States for slaughter (14). This may be due to the fact that most of the studies of rear face transport have been conducted on performance horses that are experienced with transportation and are transported in individual stalls.

Sea and air transport

The size and extent of the international horse air transport industry is seldom grasped to those unfamiliar with it. It is as stated previously, it is very difficult to quantify. However, an illustration of the size and rate of growth of this industry can be gained from measuring dual hemisphere covering or 'shuttle stallion' activity. This practice was initiated by the Coolmore Stud with Godswalk in the late 1980s. Today, as many as 100 stallions from the world's leading studs may be mated with mares in both the northern and southern hemispheres in the same year. They travel, as do so many other horses, to and from Ireland, the United Kingdom and France and also from the United States and Japan, Australia and New Zealand (Fig. 4). Horses also travel by air to and from North and South America for breeding and racing. Stallion owners are now planning to shuttle their stallions from Europe to Argentina and Brazil.

Quarantine regulations are applied to this travel and trade. These regulations may vary from country to country, but are always intended to prevent the spread of disease. Many horse populations are, in disease terms, 'naive', i.e. they would be highly susceptible to infections that occur elsewhere. Equine influenza caused havoc in South Africa in the 1980s. Ten years ago, this disease was estimated to have the potential of causing

Figure 4
Unloading horses after a long haul flight from the European Union to New Zealand

losses of US$220 million per month, had it then reached Australia. The current outbreak in 2007 is believed to cost more than this each week. The foot and mouth disease crisis in the United Kingdom has resulted in additional pre- export safeguards and has necessitated the quarantining of United Kingdom horses in Ireland, prior to their export to Australia. Stallions and mares have completed their quarantine in strict isolation at approved facilities on private and public stud farms in Ireland, France and in the United States. They are cleared for export, under government supervision and travel by road to various airports, in a variety of vehicles. The entire and complex process is organised and supervised by bloodstock transport specialists who literally arrange and supervise the transfer of horses from door to door.

On arrival at the airport, horses are transferred to air stables or jet stalls (Fig. 5), if they are travelling in so-called 'wide bodied jets' (Boeing 747 jumbo jet and MD11 jet) (Fig. 6). The evolution of the jet stall has revolutionised the international transport of horses in the last 10 years or so. 'Jet stall' arrangements have today largely superseded the previous 'open stalls', other than in the narrower bodied, previous generation aeroplanes, many of which are still in use, or short haul aircraft used to transport racehorses around Europe and elsewhere. Designed to confine horses in safety at altitude, jet stalls facilitate rapid loading and unloading which is an essential feature of all large-scale modern air cargo activity. These stalls have been designed to accommodate a maximum of three horses, side by side, separated by partitions. Access to the horses for feeding and watering and for their expert travelling grooms is provided at the front of the stalls. Flying grooms are highly experienced professionals who, in addition to their horse skills, have certified expertise in air safety.

Figure 5
Jet stalls (air stables) on the runway, waiting to be loaded onto an aircraft

Figure 6
Horses in jet stalls on the cargo deck of a Boeing 747

Perhaps placing three horses in a jet stall can be likened to travelling 'economy' for human air travellers. For a higher price, horses can also travel two to a stall or even enjoy a stall entirely to themselves, if economics allow, akin to 'business' or 'first class' travel for you or I. The jet stalls, once loaded and cleared by the authorities, are then transferred from the loading areas to the side of the aeroplane. Tugs or tractors bring one or more jet stalls in little trains to where they are rolled onto a scissors lift that raises them and passes them into either the front or the rear side door of the aeroplane.

The positioning of jet stalls within the aircraft (other than ensuring colts and stallions are placed in front of fillies or mares) is determined by loadmasters. They are accredited experts who ensure that all of the freight on board is loaded correctly and that is safely secured, in accordance with the weights and balance distributions specified by the aircraft manufacturer. Jet stalls may be arranged in either a single row or in two parallel rows on the main cargo deck. A maximum of 29 jet stalls containing 87 horses can be carried by a 747 jumbo jet. These jets seldom carry all horse loads. Other freight is often carried in addition to the horses. The huge 747-200 series freighter can carry a load of 200 000 lbs (90 719 kg) over a range of 4 490 miles (7 225 km) (Fig. 7).

Figure 7
Transportation of 112 horses in open-top stalls on a long haul Boeing 747 flight

Horses can therefore travel to many international destinations without a stop for re-fuelling en route. However, travel to extreme distances requires one or more re-fuelling stops and loading and unloading of other freight may take place simultaneously with refuelling.

Horses travelling to Australia and New Zealand from Ireland, the United Kingdom or France usually travel eastwards and may have re-fuelling/loading and unloading stops in continental Europe, the Middle East and Singapore. Insect-proof netting must be fitted to the jet stalls if horses have to change planes in Singapore, to prevent the introduction of insect-borne diseases. United States-based horses travelling to the southern hemisphere go west across the Pacific and usually depart from either Chicago or Louisville Kentucky, with possible stops on the west coast of the United States, Hawaii and Fiji. Most horses tolerate confinement, jet noise and repeated take-offs and landings remarkably well.

Dedicated handlers offer horses water every 4 h to 6 h throughout their journey and hay or haylage is usually made available to them throughout the flight. Veterinary care is provided where economics permit. Although some lose no weight during the journey, it is not unusual for horses to lose about 20 kg or 4% of their bodyweight on a journey that lasts 24 h.

Some horses can suddenly and unpredictably resent confinement. This occurs in less than half of one per cent of horses that travel. Caring attention and re-assurance, physical restraint and access to modern injectable tranquillisers are generally sufficient to restore calm. Extreme frenzy can be almost impossible to control in such a confined space and has, very rarely, resulted in fatality. The rarity of frenzy-related deaths is a considerable tribute to the bravery of the flying grooms. Their prompt intervention has saved many lives.

Effects of transport

Cregier (7, 8) reported that transport was associated with the incidence of acute colitis, laminitis, transit tetany, trailer choke and mild azoturia. It is not clear whether such observations are caused by what has been termed 'transport stress'. Transport by road can be associated with an increase in plasma cortisol and progesterone (1, 45, 50). Increased sodium levels and blood glucose concentrations have also been measured in experienced racehorses after transport (50). Elevated heart rates (39, 46) and increased serum levels of the enzymes aspartate aminotransferase and creatine kinase have also been reported (22) as have a reactivation of salmonella infection (28) and various respiratory problems (23).

In addition to the impact of transport on the animal, consideration must be given to the frequency of injury associated with all aspects of transportation. In the United States, the

percentage of injured horses rose from 8% in single-deck vehicles to 29% in double-decked trucks/lorries. Given that there are an estimated 7 million horses in the United States, this involves a large number of animal injuries. One of the greatest causes of injury is considered to be due to fighting between unfamiliar horses transported loose on slaughter vehicles over long distances, as currently occurs between the north and south of Europe. In one study of slaughter horses, 30% of horses arriving at the slaughter plant had visible bite injuries, 8% had serious welfare problems and 25 % were found to have bruised carcases due mainly to kicks (15).

Effects on performance

Much of the work in this area is conflicting or inconclusive. For example, early embryonic death in pregnant mares being transported was reported by van Nierkerk and Morgenthal (44), but Baucus *et al.* (1) did not find this to be the case. There are a number of reports that suggest that for experienced horses, transport over short distances has little impact on their performance (2). When Slade (36) investigated the effects of rear- and forward-facing transport on post transit racing performance, no effect was found. The same seems to be the case for horses used for show jumping, although less experienced horses did exhibit signs of stress (6, 35). However, when the effects of longer journeys have been examined, there are indications that the response to transport could compromise racing performance (25). There is also the matter of the sort of exercise that is required of the horse following transport. Linden *et al.* (25) found that certain types of exercise induced different cortisol responses; and this must be taken into account when considering the impact that transportation may have. There is also the question of individuality. Some horses cope better with transport than others and recovery will depend upon the health and fitness of the individual, the way that the horse coped with the transport experience and other factors such as road type, driver technique and so on. One of the problems in studying this area is being able to develop good scientific methodology for assessing the effect of transport on 'performance'. Physiological and biochemical measures of stress (e.g. raised plasma cortisol levels, increased creatine kinase, increased heart rate) are often inconclusive since they need to be collected (which may in itself cause a stress response) and may be clinically insignificant (20).

Body weight, rectal temperature, haematology and blood biochemistry parameters were studied in 18 horses that were transported from overseas to compete in the Hong Kong Invitational Cup and Bowl races by Leadon and Watkins (24). Mean body weight fell from 496.8 kg to 478.9 kg and mean pre-flight weights were not regained by day 3 after arrival. A mild pyrexia (38.33°C) was evident on arrival and although horses that had an uneventful journey were no longer febrile by day 1, horses that had a difficult journey remained febrile until day 2. Plasma cortisol was elevated from pre-flight (5.2 ± 2.3 pg/µl) to arrival (7.9 ± 2.1 pg/µl). Polymorph neutrophils (60.6 ± 6.7%) and lymphocytes (35.1 ± 4.2%) were also significantly different on departure than on arrival (72.1 ± 53.%) and (20.5 ± 7.1%), respectively. Significant differences were also seen in packed cell volumes (43.9 ± 5.5 to 47.5 ± 3.8 l/l) and plasma albumin (32.3 ± 1.7 to 33.8 ± 1.4 g/l) in all horses on arrival and also on day 1. Plasma chloride (100.8 ± 2.8 to 102.7 ± 2.1 meq/l) changes were only present on arrival in horses that had a difficult journey. Changes also occurred in plasma bilirubin (T) (49.6 ± 15.7 to 81.8 ± 25.1 mmol/l) and aspartate aminotransferase (202.3 ± 85.2 to 237 ± 67.9 IU/l), but, again, these were evident on day 1 after arrival. Plasma fibrinogen concentration measured by the modified Clauss method did not return to pre-flight levels until day 3 after arrival (1.05 ± 0.2 to 1.2 ± 0.3 g/l).

Transport and pathology – 'shipping fever'

Like their human counterparts, a minority of equine passengers may develop aviation-related disease. Although colic and other illness may occur at altitude as they can anywhere else, the principal problem associated with the long distance transport of

horses is respiratory disease. Known colloquially as 'shipping fever', this disease has been recognised for well over 100 years, since horses had to travel to many of today's destinations by sea. From then until relatively recently, the disease had an incidence of about 6%, i.e. 94% of horses transported long distances were unaffected by the combination of pneumonia and pleurisy that is 'shipping fever' (21).

The clinical signs of this shipping fever include depression, reluctance to drink, increased rectal temperature, nasal discharge and increased respiratory rate with other signs of respiratory disease. Research by the late Daria Love and her colleagues at the University of Sydney has shown that holding a horse's head high for protracted periods, even on the ground, can pre-dispose to the development of this disease. Studies funded by the International League for the Protection of Horses and the International Equestrian Federation, and performed by the Irish Equine Centre, have shown that environmental conditions on aircraft can also contribute to the development of respiratory disease. For example, bacterial numbers in the air in the cargo hold can increase dramatically during the journey, especially at re-fuelling stops. Data loggers have been placed in jet stalls and temperature and relative humidity can be measured digitally, every minute throughout a long air journey. Although still in their early phases, these studies have illustrated the extreme variations in air moisture that can occur. Very dry air can desiccate the respiratory system and interfere with clearance from the lungs. These studies are potentially important because the incidence of shipping fever is now higher than when open stalls were the norm. Twenty percent (and sometimes even more) of horses transported long distances in jet stalls can show fever during the journey or thereafter. Modification of jet stall design may be required and this can only be done on a scientifically proven basis.

The provision of veterinary care at altitude has been shown to have significant equine welfare benefits. Trauma and frenzy can be dealt with as they arise, the very rare episodes of colic can be addressed and the duration and severity of shipping fever is much reduced as a result of diagnosis and treatment in the air. Although this section relates to air transport, shipping fever is also seen after road transport. Careful checking of horses after arrival following long journeys is essential. Taking of rectal temperatures twice daily for at least three days after arrival will identify shipping fever cases and is arguably the single most important welfare measure that anyone can initiate in the transport context. Prompt veterinary attention in any instance of fever after shipping, with the advice that any affected horse has just completed a long journey, is then essential (17).

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