Chapter 5: Animal Handling and Transport

Handling refers to how agricultural animals are touched, moved, and interacted with during husbandry procedures. Transport means when agricultural animals are moved by vehicles or vessel from one place to another.

Performance standards during handling include careful, considerate, respectful, calm, human interactions with animals in as positive a manner as is possible. Animals handled in a respectful manner will be calmer and easier to handle than animals handled in a rough or disrespectful manner.

Whenever possible, animals should be moved at a normal walking speed, and acclimating the animals to handling and close contact with people will reduce stress (Grandin, 1997a; Fordyce, 1987; Boandl et al., 1989). Research clearly shows that animals that are handled in a negative manner and fear humans have lower weight gains, fewer piglets, and give less milk and reduced egg production (Hemsworth, 1981; Barnett et al., 1992; Hemsworth et al., 2000). Cattle that become agitated during restraint in a squeeze chute or exit from the squeeze chute rapidly have lower weight gains, poorer meat quality, and higher cortisol levels compared with calmer animals (Voisinet et al., 1997a,b; King et al., 2006).

Socialization of agricultural animals with humans should be done when feasible when small numbers of animals are used for research. Socialization and gentling can be carried out with relative ease by frequent exposure to kind, gentle care. Even brief periods of handling, beginning at the youngest possible age, confer advantages for ease of handling of birds and increase feed efficiency, body weight, and antibody responses to red blood cell antigens (Gross and Siegel, 2007). For example, Gross and Siegel (1982a,b) and Jones and Hughes (1981) found that positively socialized chickens had reduced responses to stressors and that resistance to most diseases tested was better than that of birds that had not been socialized. When large numbers of animals are housed under commercial conditions, socialization may not be possible, but the flightiness can be reduced if a person either walks through the flock herds or groups of animals or walks by their cages on a daily basis.

Calm animals will also provide more accurate research results that are less confounded by handling stress. Handling and restraint stresses can significantly alter physiological measurements. Beef cattle not accustomed to handling had significantly higher cortisol levels after restraint compared with dairy cattle that were accustomed to handling (Lay et al., 1992a,b). Prolonged 6-h restraint of sheep where they could not move resulted in extremely high cortisol levels of >110 ng/mL (Apple et al., 1993). Aggressive handling should never be used for farm animals. Multiple shocks with an electrical prod more than doubled the levels of lactate and glucose in pigs compared with careful handling without electric prods (Benjamin et al., 2001; Brundige et al., 1998). Transportation performance standards include movement of animals with minimal risk of injury or death to animal or handler. Transportation is only performed when necessary. Making the transport experience more comfortable for each species should be a priority for animal handlers.

BIOMEDICAL VERSUS AGRICULTURAL RESEARCH REQUIREMENTS

For research results to be applicable to commercial agriculture, the animals have to be handled and housed in conditions similar to those on commercial farms. In these situations, many of the animals may not be accustomed to close contact with people, and commercial handling equipment such as cattle squeeze chutes and other specialized equipment will be required. In another type of research, an agricultural animal may be used for biomedical research and housed in small indoor pens that are not similar to commercial conditions. Biomedical researchers have conditioned and trained animals to cooperate with injections, restraint, and other procedures. Primates, pigs, and sheep can be easily trained to voluntarily enter a restraint device or hold out a limb for various procedures (Panepinto, 1983; Grandin, 1989a; McKinley et al., 2003; Schapiro et al., 2005). Hutson (1985) reported that providing food rewards to sheep made them more willing to move through a han-

dling facility in the future. Training animals to cooperate greatly improves welfare, and removes some effects of restraint stress on physiological data. Low levels of cortisol and glucose were obtained from unsedated antelopes that had been conditioned to enter a restraint box and voluntarily stand still for blood tests (Phillips et al., 1998).

Training animals to voluntarily cooperate with injections, blood sampling, and other procedures is definitely recommended for biomedical settings where a few animals are used for medical experiments. However, it is often not practical for agricultural research in which large numbers of animals are handled.

FLIGHT ZONE AND BEHAVIOR PRINCIPLES

People who are handling cattle, bison, sheep, horses, and other grazing animals should have knowledge of flight zone principles (Grandin, 1987, 2007a; Smith, 1998; Cote, 2003; Figure 1). The flight zone concept does not apply to animals that are trained to lead with a halter or otherwise conditioned to close human handling. The flight zone varies depending on whether cattle or other livestock have been extensively or intensively raised. Extensively raised cattle may have flight zones up to 50 m, but intensively raised cattle (e.g., feedlot) may have flight zones only 2 to 8 m (Grandin, 1989b, 2007a). The size of an alley can change flight zones. Sheep in a 2-m (6-ft)-wide alley had a smaller flight zone than sheep in a 4-m (13.5-ft)-wide alley (Hutson, 1982). An approximation of the flight zone can be made by approaching the animal and noting at what distance the animal moves away. When the handler is outside of the flight zone, cattle will turn and face the handler. Flight zones can be exploited by handlers to move cattle and other livestock efficiently and quietly. For example, handlers should be positioned at the edge of the flight zone and behind the point of balance (located at the shoulder) to move cattle forward. A common mistake made by many handlers is to stand in front of the shoulder and attempt to make an animal go forward by poking its rear. This gives the animal conflicting signals. To move the animal forward, the handler should be behind the point of balance (Kilgour and Dalton, 1984; Grandin, 1987, 2007a); Figure 1 presents the concept of flight zone and point of balance. Figure 2 shows how to move an animal forward in a chute by walking quickly past the point of balance at the shoulder in the opposite direction of desired movement (Grandin, 1998, 2007a,b; Grandin and Deesing, 2008). To cause cattle to stop or back up, handlers should be positioned ahead of the point of balance. Too deep a penetration of the flight zone may cause extensively raised cattle to bolt or run away or rear up in a chute. Animals will often stop rearing if the handler backs up and gets out of the flight zone. Personnel working with cattle should be trained to use flight zones correctly.

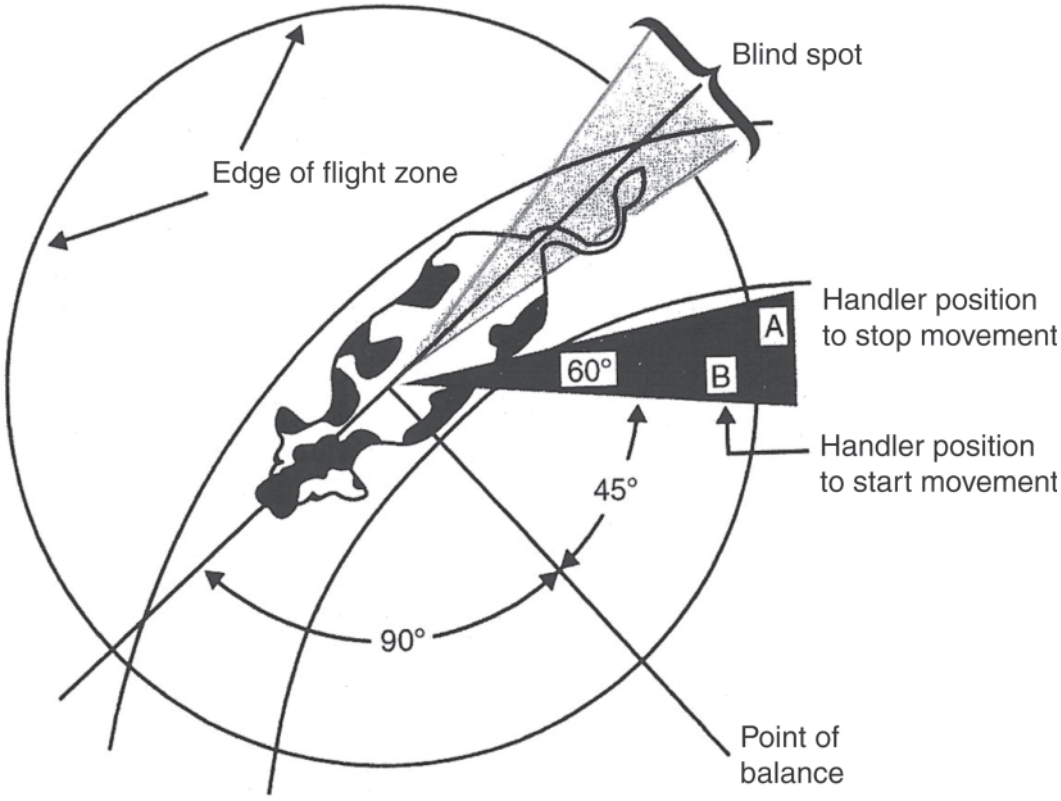

Figure 1. Flight zone diagram showing the most effective handle positions for moving an animal forward. Reproduced with permission of T. Grandin.

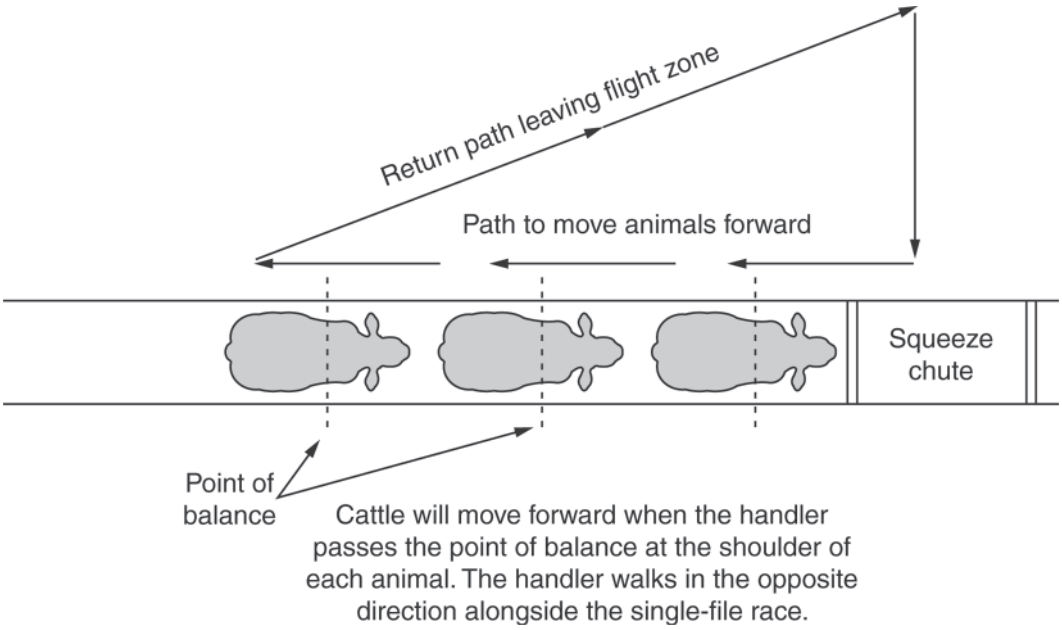

Figure 2. Handler movement pattern to induce cattle to move forward in a race. Reproduced with permission of T. Grandin.

Extensively raised grazing animals that arrive at a research facility may have a large flight zone. The size of the flight zone will gradually diminish if they are handled calmly and have frequent contact with people. Farm animals are social and a lone animal separated from its herdmate often becomes severely agitated. Many injuries to both people and animals occur when a single lone animal runs into a fence or charges. An agitated lone animal can be calmed by putting some other animals in with it.

Cattle and sheep will follow a leader (Arnold, 1977; Dumont et al., 2005). When one of the animals starts to move, the others will follow. Natural following behavior can be used to facilitate calm movement of animals. If animals are calmly moving in the desired direction, the handler should back up and stop putting pressure on the flight zone. Continuous pressure on the flight zone may cause animals to start running, which is undesirable.

AIDS FOR MOVING ANIMALS

Animals in properly designed facilities may be moved using their natural behavior and without the use of any aids. The goals of movement should be to minimize stress to each individual animal, reduce fear, and maintain calmness in all animals. All handlers should be trained in the natural behavior of the species including their flight zone and in proper handler movement and interaction, and be able to recognize any signs of distress, anxiety, or behaviors that may result in injury or stress to the animals. When necessary, nonelectrical driving aids such as paddles, flags, and panels may be an adjunct with the use of natural behavior and handling skills. Handlers should be trained in the proper and effective use of each driving aid, which is appropriate to the species.

An electric prod should only be picked up and used in a specific situation where it is needed and then put away. Handlers have a better attitude toward the animals when electric shocks are not used (Coleman et al., 2003). Data collected at meat plants indicate that most cattle and pigs could be moved throughout an entire handling system without electric prods (Grandin 2005). On a ranch or feedlot, the use of electric prods should be limited to 10% or less of the cattle (NCBA, 2007).

When an electric prod needs to be used, it should be applied to the hindquarters of the animal. Usually 1 to 3 brief shocks are needed. If the animal does not respond, the use of the electric prod should be discontinued immediately. It should never be applied to sensitive areas of the animal such as the eyes, ears, genitals, udder, or anus. Battery-operated prods are recommended because they administer a localized shock between 2 prongs. Electric prods should not be used on newborn animals, debilitated weak animals, nonambulatory downed animals, or emaciated animals. Electric prods are highly stressful to pigs. Repeated shocks greatly increased the percentage of nonambulatory pigs (Benjamin et al., 2001). Multiple shocks and aggressive handling significantly increased blood lactate and other indicators of metabolic stress compared with gentle handling (Ritter et al., 2009). Pigs that become nonambulatory because of fatigue or porcine stress syndrome should not have electric prods used on them.

Some examples of the use of an electric prod as a last resort or if human or animal safety is in jeopardy are listed below:

Table 5-1. Visual distractions that may cause animals to balk and refuse to move[1]

- Sudden changes in floor structure or surface such as drain grates, objects on the floor or change in flooring material.
- Shadows, puddles, and shafts of light; seeing light through a slatted floor.
- Animals may refuse to enter a dark place. Use indirect lighting to facilitate movement toward the light. Animals tend to move from a darker place to a more brightly illuminated place, but they will not move into blinding light.
- Reflections on a wet floor or shiny metal. Move lights to eliminate the reflection or use non-reflective surfaces.
- Moving people in front of approaching animals. People should stand where approaching animals do not see them.
- Jiggling chains, coats on a fence, flapping plastic, or swinging ropes. Remove these distractions.
- Animals see people, moving objects such as vehicles or objects with high color contrasts outside of the chute. Improve movement by installing solid sides.

[1]This table is adapted from information in Kilgour (1971), Lynch and Alexander (1973), Hutson (1981), Grandin (1980a,b, 1982–1983, 1996), van Putten and Elshof (1978), Kilgour and Dalton (1984), Tanida et al. (1996), Grandin and Johnson (2005), and Grandin and Deesing (2008).

1. To move an animal after repeated attempts with nonelectrified driving aids such as a plastic bag on the end of a stick, flags, slappers, rattle paddles, or streamers tied to the end of a stick have failed; the use of an electric prod is preferable to beating, ragging, pushing, or hard tail twisting of animals. If excessive slapping or electric prodding is required routinely, then the personnel involved may be too anxious or inadequately trained in proper animal handling or the facility may need modifications. Smaller animals may be gently lifted or rolled onto a transport mechanism.
2. To get a downed (fallen) animal in a truck that is located at a truck stop on the side of a highway. In this situation, opening up the truck gates or unloading the animals is not possible.
3 For cattle that are choking in a head stanchion or headgate or become jammed in a chute or other equipment.

Animal Perception

Hearing. All species of grazing animals have sensitive hearing. Cattle and horses have hearing that is more sensitive compared with humans to high-pitched sounds (Heffner and Heffner, 1983). The human ear is most sensitive at 1000 to 3000 Hz and cattle are most sensitive to 8000 Hz (Ames, 1974; Heffner and Heffner, 1983). Handlers should not yell or shout at cattle because shouting may be just as aversive as an electric prod (Pajor et al., 2003). In another experiment, the sounds of people yelling caused a greater increase in heart rate than the sounds of gates clanging (Waynert et al., 1999).

Intermittent or high-pitched sounds caused greater behavioral reactions and increased heart rate in pigs compared with steady or low-pitched sounds (Talling et al., 1998). Intermittent sounds and rapid movements are also more likely to cause cattle to react (Lanier et al., 2000). Handlers should be observant of the position of an animal's ears. Horses and cattle will point their ears directly toward things that attract their attention (Grandin, 2007a).

Vision. Cattle, sheep, and horses have wide-angle vision and they can see all around themselves without turning their heads (Prince, 1970; Hutson, 1980; Kilgour and Dalton, 1984). Grazing animals have depth perception when they are standing still with their heads down (Lemmon and Patterson, 1964). Depth perception is probably poor when the animals are moving with their heads up. This explains why they stop and put their heads down when they see a shadow on the floor.

Grazing animals are dichromats (i.e., have partial color-blindness). The retinas of cattle, sheep, and goats are most sensitive to yellowish-green; (552–555 nm) and bluish-purple light (444–455 nm) (Jacobs et al., 1998). The dichromatic vision of the horse is most sensitive at 428 and 539 nm (Murphy et al., 2001). Dichromatic vision and the absence of a retina receptor for red may explain why livestock are so sensitive to sharp contrasts of light and dark such as shadows or shiny reflections on handling equipment.

Poultry appear to have excellent vision. Chickens and turkeys possess 4 cone-cell types in the retina giving them tetrachromatic color vision, compared with the human trichromatic vision based on 3 cone-cell types (Lewis and Morris, 2000). Moreover, the spectral sensitivity of chickens is greater than that of humans from 320 to 480 nm and 580 to 700 nm. Their maximum sensitivity is in a similar range (545–575 nm) to humans (Prescott and Wathes, 1999). The broader spectral sensitivity of poultry may make them perceive many light sources as being brighter than a human would see. Poultry may be more docile during handling in blue light spectra (Lewis and Morris, 2000). Lighting conditions have a large effect on chicken behavior when the birds are shackled for slaughter (Jones et al., 1998). During handling of poultry, the occurrence of flapping should be minimized. Changes in lighting may be used as one tool to keep birds calmer during handling.

Effects of Visual Distractions and Handling

Livestock of all species will often refuse to move through a chute or other handling facility if they see distractions such as shadows, reflections, or people ahead

of them. Removing distractions that cause animals to balk and stop will facilitate animal movement (Kilgour and Dalton, 1984; Grandin, 1996; Grandin and Johnson, 2005; Grandin, 2007a). A calm animal will stand and point its eyes and ears toward distractions that attract its attention. If the leader is allowed to stop and look at a distraction, it will often move forward and the other animals will follow. If the animals are rushed, they may turn back and refuse to move forward when they see a distraction. Distractions are most likely to cause balking or other handling problems if the animals are not familiar with the facility. Experienced dairy cows will often ignore a distraction such as a floor drain, but new, inexperienced heifers will balk at it. Table 5-1 contains a list of distractions that may cause animals to balk and refuse to move. This list can be used as a guide for modifying handling facilities where excessive use of electric prods is occurring. In facilities where animals move easily and quietly and electric prods are seldom used, removal of distractions may not be needed.

Facility Design Principles for all Species

Flooring. For all species, nonslip flooring is essential (Grandin 1990, 2007b; Albright, 1995; Grandin and Deesing, 2008). Animals often become agitated when they start slipping. Handling and restraint will be safer and animals will remain calm if animals have nonslip flooring (e.g., grooved concrete, rubber mats, or metal rod grids). Handling facilities should have nonslip floors and good drainage.

Equipment Maintenance. Surfaces that contact the animals must be smooth and free of sharp edges that could injure animals. Sharp edges will cause bruises (Grandin, 1980c) and injury. Managers should routinely inspect equipment and have a program of regular maintenance based on use. Special attention should be paid to latches on restraint devices.

Sanitation. Managers should regularly inspect facilities to ensure cleanliness. When new facilities are being designed, ease of cleaning is an important part of the design. Concrete curbs can be used to direct manure to a drain. Hoses, shovels, and other tools that are needed for cleaning should be readily available. Sanitation equipment should be removed after routine cleaning.

Animal handling facilities should be regularly cleaned after use and maintained in good working condition. Injuries and accidents can happen to animals and handlers from equipment lockup or other problems that can occur with build-up of filth, breakage, or wear and tear. Managers should routinely inspect the facilities to ensure cleanliness and to maintain a regular maintenance schedule based on use.

GENERAL PRINCIPLES OF RESTRAINT AND HANDLING

Training of animal care personnel in handling procedures should include consideration of the well-being of the animals. During the handling and restraint of animals, care should be exercised to prevent injury to animals or personnel. Animals should be handled quietly but firmly. Properly designed and maintained facilities operated by trained personnel greatly facilitate efficient movement of animals.

Prolonged restraint of any animal must be avoided unless such restraint is essential to research or teaching objectives. The following are important guidelines for the use of animal restraint equipment:

- Animals to be placed in restraint equipment ordinarily should be conditioned to such equipment before initiation of the project, unless the preconditioning itself would increase the stress to the animals.
- The period of restraint should be the minimum required to accomplish the research or teaching objectives.
- Electrical immobilization must not be used as a method of restraint. It is highly aversive to cattle and sheep (Grandin et al., 1986; Lambooy, 1985; Pascoe and McDonnell, 1985; Rushen, 1986). Electrical immobilization must not be confused with electrical stunning that causes instantaneous insensibility or electric prod use that does not immobilize animals.
- Restraint devices should not be considered normal methods of housing, although they may be required for specific research and teaching objectives.
- Attention should be paid to the possible development of lesions or illness associated with restraint, including contusions, knee or hock abrasions, decubital ulcers, dependent edema, and weight loss. Health care should be provided if these or other serious problems occur, and, if necessary, the animal should be removed either temporarily or permanently from the restraint device. Animals should be handled and restrained in facilities and by equipment appropriate for the species and procedure.

Some aggressive behaviors of larger farm animals pose a risk to the health and well-being of both herdmates and human handlers. These behaviors may be modified or their impact reduced by several acceptable restraint devices (e.g., hobbles, squeeze chutes, and stanchions) and practices. Only the minimum restraint necessary to control the animal and to ensure the safety of attendants should be used. Care should be exercised when mixing animals to minimize fighting, especially when animals are grouped together for the first time.

Animals should be handled and restrained in facilities and by equipment appropriate for the species and procedure. For cattle, for example, a chute facility should be available (particularly one suited to obstetrical procedures, if appropriate). Unless they are very young or tame, calves restrained for routine procedures should be handled by means of a calf chute equipped with a calf cradle.

PRINCIPLES TO PREVENT BEHAVIORAL AGITATION DURING RESTRAINT FOR ALL SPECIES

The following guidance is provided to prevent behavioral agitation:

- Nonslip flooring should be provided (Grandin, 1990; Albright, 1995). Repeated small rapid slips may cause agitation.
- Avoid sudden jerky motion of either people or equipment. Smooth movements will keep animals calmer (Grandin, 1992).
- When an animal is raised off the ground, during restraint, it will usually remain calmer if its body is fully supported.
- Even pressure over a wide area of the body has a calming effect (Ewbank, 1968). The Panepinto sling for small pigs and cattle squeeze chutes use this principle (Panepinto, 1983; Grandin, 2007b).
- A calm, confident tone of voice will help keep livestock calmer.
- Optimum pressure—not too loose and not too tight. An animal needs to be held tight enough to feel the feeling of restraint, but not so tight that it feels pain. Excessive pressure will cause struggling (Grandin, 1992).
- Blocking vision: using a blindfold made from a completely opaque material will often keep cattle and horses with a large flight zone calmer (Mitchell et al., 2004). Solid sides on cattle chutes or a fully enclosed dark box have a calming effect (Grandin, 1980a,b, 1992; Muller et al., 2008; Pollard and Littlejohn, 1994).

RECOMMENDATIONS FOR EACH SPECIES

Beef Cattle Handling

Animals that are extensively raised and have large flight zones may become agitated if people stand close to the chutes and pens in the handling facility. If this occurs, solid fences may need to be installed so the animals do not see the people that are deep in their flight zone. Further information on facility design is in Grandin (1990, 1997b, 2007b) and Grandin and Deesing (2008).

There are many different designs of restraining (squeeze) chutes. Squeeze chutes should permit all animals to stand in a balanced position and the squeeze sides are applied evenly on both sides. Squeeze chutes may be hydraulic or manual models. Settings of pressure relief valves for hydraulic restraint chutes should be adjusted to prevent excessive pressure from being applied (Grandin, 1989b). The chute should automatically stop squeezing at a reasonable pressure even if the operator continues to pull on the squeeze lever. A separate pressure control is required on chutes that have a hydraulic device for restraining the head. To avoid animal injury, this device must be set at a lighter pressure than other parts of the chute. Pressure should be applied slowly to avoid exciting the animal. Excessive pressure can cause injury and incite cattle to fight the restraint. If cattle bellow the moment pressure is applied by a hydraulic device, this is an indicator of excessive pressure (Grandin, 2001). Bellowing during restraint is associated with higher cortisol levels (Dunn, 1990). Cattle should be able to breathe normally during restraint. The head gate can be self-catching or manually operated. Self-catching head gates are generally not recommended for use with horned cattle unless they are operated manually. Unless they are very young or tame, calves restrained for routine procedures should be handled by means of a calf chute equipped with a calf cradle.

Roping of cattle is necessary under certain conditions (e.g., in pastures when an animal needs treatment and no restraining facility is conveniently available). However, roping should be performed by trained and experienced personnel and in a manner that minimizes stress to both the individual and the total herd. For head restraint of cattle in a squeeze chute, a properly fitted rope halter is recommended. Nose tongs may be used on fractious animals in conjunction with other means of cattle restraint (e.g., squeeze chute), but nose tongs can slip and tear out of the nose, causing injury to both animal and personnel, and therefore are not recommended as a sole means of restraint. Nose tongs are aversive and cattle may resist the attachment of the tongs in the future. For repeated procedures that require head restraint, a rope halter is strongly recommended. Electroimmobilization must not be used as a method of animal restraint; cattle and sheep find this procedure very aversive (Pascoe and McDonnell, 1985; Grandin et al., 1986; Rushen, 1986).

Plastic streamers or a grocery bag tied to the end of a stick is an effective device for moving cattle and changing their direction (Grandin, 2007a). Cattle temperaments vary among individuals and among breeds (Tulloh, 1961; Grandin, 1993; Curley et al., 2006). Handling should be adjusted for genetic and phenotypic differences.

Dairy Cattle Handling

Mature milking dairy cows can be handled in head stanchions or a management rail (Albright and Fulwider, 2007). A complete squeeze chute is not required. Diagrams and pictures in Sheldon et al. (2006) illustrate methods for restraining tame dairy cows when they are held in a head stanchion. Young dairy heifers that are not accustomed to close contact with people are often handled most efficiently and safely in beef-type facilities with a squeeze chute.

Disturbances by veterinarians and other visitors can reduce milk yield (King, 1976). If the cows are accustomed to many people walking through the milking parlor, there may be no effect because the frequent visitors have become part of their normal routine. Dairy animals are able to discriminate between people who have handled them in a negative manner and people who handled them in a positive manner (dePassillé et al., 1996). They were most likely to avoid the negative handler when he was seen in the same location where the aversive events occurred.

Dairy bulls are usually more dangerous than beef bulls. Bull attacks are a major cause of fatalities when people are working with livestock. One of the reasons beef bulls are safer is that they are reared in a social group on a cow. Price and Wallach (1990) found that beef bulls attacked more often when they were raised in individual pens. A dairy bull calf raised to maturity alone in a pen is more likely to be dangerous than a bull that was always kept with other animals. If a bull is going to become dangerous, he is most likely to show aggression toward people at 18 to 24 mo. Handlers must learn to recognize signs of aggression that precede an attack such as the broadside threat. The bull will turn sideways to show how big he is before he attacks. Good descriptions are in Albright and Arave (1997) and Albright and Fulwider (2007). Bulls that show aggressive tendencies toward people should be culled or transferred to a secure facility.

Horse Handling

Teaching and research horses are usually handled using halters and lead ropes, and extra control may be achieved by using the chain of a lead shank placed over the horse's nose. Only trained horses should be tied and only to solid objects that will not give way if the horse pulls back. Lead ropes attached to the halter should be tied with quick release knot. Horses should never be tied with a chain looped across the top of the nose. Cross-ties attached to each side of the halter should be equipped with panic-snaps or safety releases. A twitch may be applied to the horse's upper lip as a short-term restraint procedure (Sheldon et al., 2006). The movement of a horse may be restrained in stocks and chutes. An equine stock or chute may be as simple as a rectangular structure with a nonslip floor. Other methods of restraint that may be applied by experienced individuals include front foot hobbles, sideline or breeding hobbles, or leg straps, but should be carefully considered depending on the training of the individual horse and the degree of restraint necessary.

Chemical restraint can be effective and should be administered by a qualified person. With some drugs, an apparently sedated horse may react suddenly and forcefully to painful stimuli (Tobin, 1981). General or local anesthesia should be administered by a qualified person, preferably a veterinarian, for painful procedures such as castration.

Swine Handling

Snaring by the nose is a common method for holding swine for blood testing and other procedures. Good descriptions are in Battaglia (1998) and Sheldon et al. (2006). Snaring is probably stressful for pigs because they will attempt to avoid the snare after they have experienced snaring. For biomedical research, small pigs can be trained to enter the Panepinto sling (Panepinto, 1983). The animal is fully supported in a sling and its legs protrude out through leg holes. A panel is the best device for moving pigs (McGlone et al., 2004). Nonelectric driving aids such as cattle paddles and flags can also be used by properly trained people. Guidelines on electric prod use are in the section on driving aids. Previous experiences with handling and the amount of contact with people will affect the ease of pig movement. Pigs with previous experiences of being calmly moved may be easier to move in the future (Abbott et al., 1997; Geverink et al., 1998). Calm, nonthreatening movements of people will reduce stress levels in pigs and make them more willing to approach people (Hemsworth et al., 1986).

Sheep and Goat Handling

Sheep and goats show strong flocking behavior in pens as well as on pasture. Breed, stocking rate, topography, vegetation, shelter, and distance to water may influence flocking behaviors. Isolation of individual sheep or goats usually brings about signs of anxiety. Separations from the flock, herd, or social companions are important factors that cause sheep and goats to try to escape. Sheep and goats tend to follow one another even in activities such as grazing, bedding down, reacting to obstacles, and feeding (Hutson, 2007). When handling sheep and goats, these characteristic behaviors should be considered and used advantageously and, more importantly, for the best interest of the animal's health and welfare.

Transportation of sheep and goats should take into consideration the climatic conditions and productive stage (e.g., late pregnancy or dams with young offspring) of the animals. Care should be exercised in the transport of animals, and special consideration should

be given during conditions of temperature extremes and high humidity. Measures such as increasing the supply of nutrients immediately before long-distance transport that may reduce the risk of pregnancy toxemia and transport tetany in sheep and goats should be considered. Except for short distances when hauling is less physically taxing than trailing, transportation of ewes and does during late gestation should be avoided. When possible, animals should be gated off into smaller groups during transport to prevent pileups and death losses. Additionally, temperature extremes or exposures should be considered and adequate and appropriate crating provided. Preventative or prophylactic medicinal agents (e.g., antibiotics and pre-transport vaccinations) may also be administered in an effort to minimize diseases that are associated with shipping.

The Sheep Production Handbook (American Sheep Industry Association, 2002) and *Sheep Care Guide* (Shulaw, 2005) contain detailed information about handling facilities and transportation. Sheep can be easily trained to enter a squeeze tilt table (Grandin, 1989a). The Panepinto sling can also be used for sheep. Some restraint devices are more aversive than others. Well-designed restrainers support the animal's body and do not have sharp pressure points. Both sheep and goats can be easily trained to enter head stanchions. Sheldon et al. (2006) and Battaglia (1998) have illustrated guides on manual methods for holding sheep and goats. Designs for sheep races and corrals can be found in Barber and Freeman (2007) and American Sheep Industry Association (2002).

Poultry Handling

Poultry are handled in many experimental and teaching situations. Examples include wing- or leg-banding, immunization by intramuscular and subcutaneous injections, intranasal or intraocular application of drops and wing-web puncture, and removing or placing birds in different groups, cages, or holding and transportation crates. Injured, diseased or birds for transport should be euthanized on the farm. They should not be placed in transportation crates. People handling birds should be adequately trained so that stress to birds is minimal.

Poultry that are not familiarized to humans tend to struggle vigorously when caught. They can easily be injured if grasped improperly or subjected to excessive force. All poultry tend to flap their wings when caught, inverted, or caused to struggle for balance or footing. This tendency leads to risk of joint dislocation, bone fracture, or bruises when wings strike objects or other birds. The risk is particularly great for modern varieties of market-weight meat-type birds, which have powerful breast muscles but relatively weak joints due to their youth, or for caged light hybrid (White Leghorn) laying hens, which have fragile wing bones. Poultry should be handled in ways that minimize wing-flapping or its harmful consequences. Care should be taken to prevent birds from striking their wings on door edges when placing them into or pulling them from cages or compartments. Particular care should be exercised in handling caged laying hens, which are prone to osteoporosis (Rennie et al., 1997; Webster, 2004). To minimize the risk of bone fracture, hens should be held by both legs when removing them from the cage (Gregory and Wilkins, 1989; Gregory et al., 1993). The manner in which a bird is carried can affect its fearfulness and stress. Broilers carried even briefly in the inverted position by the legs show a greater corticosterone response than do birds carried in an upright position, and the response lasts for about 3 h (Kannan and Mench, 1996). Therefore, birds should be carried upright whenever possible. Birds struggle less if they have been socialized, the body is fully supported in an upright position with wings restrained, the environment is relatively quiet, and the lighting is subdued.

Poultry should not be picked up or moved by one wing unless the wing is grasped near the base of the wing close to the body. They should quickly be released from such a hold, as when transferring birds from a coop to a floor pen.

They should be shifted to a hold that firmly grasps both wings at their bases or that supports the body to minimize struggle and chance of a limb injury. Ducks should not be caught by the leg because they are prone to leg injury if handled in this way.

Large, strong birds such as turkey toms can be difficult to control by grasping a limb. They can also deliver punishing blows with their wings when struggling against capture. To pick up a very large turkey such as breeder tom, grasp one wing near the base of the body and then grasp the leg on the opposite side and set the bird's breast on the floor. Finally, proceed with restraining the bird by grasping both legs. For intermediate-sized turkeys, the base of the wing and then both legs can be grasped simultaneously while lifting the turkey off the floor. Turkeys and ducks can be driven, so catching and handling of individual birds can be minimized by judicious use of alleys, ramps, and driving techniques when flocks must be relocated. However, some birds such as older turkeys will not walk on different surfaces and therefore may have to be moved by individual handling.

In many experimental and teaching situations, newly hatched birds or relatively small numbers of older birds need to be handled. In those cases, individuals can be easily caught and manipulated. Examples included wing- or leg-banding; immunization by intranasal or intra-ocular application of drops and wing-web puncture; and removing or placing birds in different groups, cages, and holding crates. Trained and experienced scientists and caretakers know that birds struggle less if they have been socialized, if the environment is relatively quiet, and if the body is fully supported in an upright position (Gross and Siegel, 2007). More complex procedures; for example, obtaining blood samples,

Table 5-2. Recommended minimum area allowances in transportation accommodations for groups of animals used in agricultural research and teaching[1]

	Average BW		Area per animal			
Species	(kg)	(lb)	(m^2)		(ft^2)	
Cattle (calves)	91	200	0.32		3.5	
	136	300	0.46		4.8	
	182	400	0.57		6.4	
	273	600	0.80		8.5	
			Horned		Hornless	
			(m^2)	(ft^2)	(m^2)	(ft^2)
Cattle (mature fed cows and steers	364	800	1.0	10.9	0.97	10.4
	455	1,000	1.2	12.8	1.1	12.0
	545	1,200	1.4	15.3	1.4	14.5
	636	1,400	1.8	19.0	1.7	18.0
Small pigs	4.54	10	0.060	0.70		
	9.07	20	0.084	0.90		
	13.60	30	0.093	1.00		
	22.70	50	0.139	1.50		
	27.20	60	0.158	1.70		
	31.20	70	0.167	1.80		
	36.30	80	0.177	1.90		
	40.80	90	0.195	2.10		
			Winter		Summer	
Market swine and sows	45	100	0.22	2.4	0.30	3.0
	91	200	0.32	3.5	0.37	4.0
	114	250	0.40	4.3	0.46	5.0
	136	300	0.46	5.0	0.55	6.0
	182	400	0.61	6.6	0.65	7.0
			Shorn		Full fleece	
Sheep	27	60	0.20	2.1	0.21	2.2
	36	80	0.23	2.5	0.24	2.6
	45	100	0.26	2.8	0.27	3.0
	55	120	0.30	3.2	0.31	3.4
			Dimensions		Area	
			(m)	(ft)	(m^2)	(ft^2)
Loose horses	250 to 500	550 to 1100	0.7 × 2.5	2.3 × 8.2	1.75	18.8
Foals <6 mo			1.0 × 1.4	3.3 × 4.6	1.4	15.2
Young horses 6–24 mo			0.76 × 2.0	2.5 × 6.6	1.2	16.5
			1.2 × 2.0	3.9 × 6.6	2.4	25.8

[1]Adapted from data of Grandin (1981, 2007c); Cregier (1982); Whiting and Brandt (2002); Whiting (1999); ILAR Transportation Guide (2006); and National Pork Board (2008) *Trucker Quality Assurance Handbook*.

intraperitoneal and venous puncture, and artificial insemination, often require at least 2 experienced persons. Skilled operators should adequately train personnel in such handling procedures so that stress to birds is minimal. Particular care should be exercised in handling caged layers to minimize the risk of bone fractures (Gregory and Wilkins, 1989).

When large numbers of birds housed under commercial conditions are to be moved or treated, handling methods need to be compatible with the housing systems involved (Weeks, 2007). A source of major concern should be the manner in which individual birds are caught, carried, and placed in new quarters or crates. In many situations, birds are at risk of injury because they are caught and moved by grasping a single wing with subsequent exertion of excessive force in moving the bird. No types of poultry should be picked up by one wing. Gregory and Wilkins (1989) found that when laying hens were caught by one leg and removed from cages at the end of lay, the incidence of broken bones was 12.7%; the incidence was only 4.6% when both legs were used in removing hens from the cages. On com-

mercial broiler farms, the chickens are usually picked up by a single leg. Leg breakage can be reduced if the birds are carried a short distance to the transport cage. When research is done under commercial broiler farm conditions, it is acceptable to pickup broiler chickens in this manner.

TRANSPORT

The transport of livestock involves a complex series of operations including handling, loading and unloading, unfamiliar environments, and, in some cases, isolation, social disruption, confinement, loss of balance, fluctuations in environmental temperature and humidity, exposure to pollutants (e.g., truck exhaust), feed and water deprivation, and other factors. Hence, it is often difficult to determine with precision which component or combination of components is most responsible for transportation stress. Therefore, it becomes important to pay attention to all components and the potential for cumulative effects on the well-being of the animals to be transported. In-depth reviews and research on space allowances for each species of livestock have been published for cattle (Eldridge et al., 1988; Tarrant et al., 1992; Knowles, 1999; Eicher, 2001; Swanson and Morrow-Tesch, 2001; Fike and Spire, 2006), sheep (Cockram et al., 1996; Knowles et al., 1998), pigs (Guise et al., 1998; Warriss, 1998; Whiting and Brandt, 2002; Ritter et al., 2006; Sutherland et al., 2009), and horses (Stull, 1999; Whiting, 1999; Friend, 2000a,b). In addition, the National Academy of Sciences published recommendations (ILAR Transportation Guide, 2006) for the transport of research animals that include space requirements during transport that are consistent with the guide. In the absence of data supporting specific space requirements of farm animals during transport, formulae from ILAR Transportation Guide (2006) may be useful in determining space allowances during transport. The minimum areas per animal for animals of different weights when shipped in groups are given in Table 5-2.

The safety and comfort of the animal should be the primary concerns in the transportation of any animal. Nonambulatory or weak, debilitated animals must not be loaded or transported unless necessary for medical attention. Animals that are nearing the time of parturition should not be transported. The only exception to this is when moving an animal a short distance to the place where it will give birth or to a hospital facility. If animals become injured or nonambulatory during the course of transport, appropriate steps should be taken immediately to segregate such animals and attend to their needs. Specialized carts and sleds, canvas tarpaulins, or slide boards are recommended for offloading nonambulatory animals. Animals must not be dragged, hoisted, or dropped from transport vehicles. If the animal cannot be removed with the use of recommended devices, then the animal should be euthanized by trained personnel using acceptable methods established by the AVMA (2007). Non-ambulatory animals in research and teaching facilities must be euthanized using approved procedures unless they are receiving medical treatment (see Chapters 2 and 6 through 11) before removal (Grandin, 2007c; *Humane Slaughter Act Regulations*).

If young or newborn calves are to be transported, individual care and colostrum should be provided within 2 to 3 hours after birth. Calves should always have a dry hair coat, dry navel cord, and be able to walk easily without assistance before being transported. They only exception to this recommendation is when calves are transported a short distance to a specialized calf rearing facility. In all species, weak newborns, emaciated animals, animals with severe injuries or animals that have great difficulty walking must never be transported to livestock auctions or markets.

When animals are transported, they should be provided with proper ventilation and a floor surface that minimizes slipping. When possible, animals should be shipped in groups of uniform weight, sex, and species. Stocking densities affect stress-related plasma constituents and carcass bruising as well as behavioral parameters of cattle (Tarrant et al., 1988, 1992). Similar results have been found for swine (Lambooy and Engel, 1991; Knowles and Warriss, 2007) and sheep (Cockram, 2007).

Animal injuries, bruises, and carcass damage can result from improper handling of animals during transport. Grandin (1980c) identified rough handling, mixing of animals of different sexes, horned animals, and poorly designed, maintained, and broken equipment as major causes of carcass damage in cattle. Recommendations for facility design, loading and unloading trucks, restraint of animals, and animal handling in abattoirs have been published (Grandin, 1980a,b, 1982–1983, 1990, 2007d). Good driving practices such as smooth acceleration and no sudden stops will help reduce injuries from animals being thrown off balance.

Table 5-3. Truck set-up procedures during temperature extremes for pigs[1]

		Side slats	
Air temperature, °C (°F)	Bedding	Closed, %	Open, %
<−12 (<10)	Heavy	90	10[2]
−12 to −7 (10 to 20)	Medium	75	25[2]
−7 to 4 (20 to 40)	Medium	50	50
4 to 10 (40 to 50)	Light	25	75
>10 (>50)	Light[3]	0	100

[1]Source: National Pork Board (2008) *Trucker Quality Assurance Handbook*.

[2]Minimum openings are needed for ventilation even in the coldest weather.

[3]Consider using sand or wetting bedding if it is not too humid and trucks are moving.

Thermal Environment on the Vehicle

Transport and handling stresses can be aggravated greatly by adverse weather conditions, especially during rapid weather changes. Hot weather is a time for particular caution. The Livestock Weather Safety Index is used as the basis for handling and shipping decisions for swine during periods of weather extremes. The values for cattle are conservative especially for heat-tolerant Brahman and Brahman crosses (Grandin, 1981, 2007c).

Animals should be protected from heat stress while in transit. For all species, heat will build up rapidly in a stationary vehicle unless it has mechanical ventilation. Arriving vehicles should be promptly unloaded and vehicles should start moving promptly after loading. If a loaded truck has to be parked during hot weather, fans or water misters should be provided to keep animals cool. Chickens and pigs are especially prone to heat stress. Banks of fans beside which a loaded truck can park are used extensively in the pork and poultry industries. Further information on the thermal environment can be found in the National Research Council's *Guidelines for Humane Transportation of Research Animals* (ILAR Transportation Guide, 2006). The thermal neutral zones for different animals can be found in Robertshaw (2004). Means of protection include shading, wetting, and bedding with wet sand or shavings when livestock are at high density (e.g., on a truck) and air speed is low (e.g., the truck is parked) during hot weather.

During transportation, animals should also be protected from cold stress. Wind protections should be provided when the effective temperature in the animal's microenvironment is expected to drop below the lower critical level. Recommendations for protecting animals from cold stress are in Grandin (2007c) and the National Pork Board (2008) *Trucker Quality Assurance Handbook* (Table 5-3). Adequate ventilation is always necessary. During cold weather, trucks transporting livestock should be bedded with a material having high thermal insulative properties (such as chopped straw) if the animals will spend more than a few minutes in the transport vehicle. This is especially important for pigs to reduce death losses (Sutherland et al., 2009). Currently there are no trucking quality assurance recommendations for space allowance of weaned pigs during transport in the United States. A space allowance of 0.06 and 0.07 was preferable to 0.05 m^2/pig when transporting weaned pigs between 60 and 112 min in summer (28.4 ± 1.2°C) and winter (10.5 ± 6.15°C) based on neutrophil:lymphocyte ratio and behavior (Sutherland et al., 2009). However, the effect of space allowance on the welfare of weaned pigs may differ when for transport durations longer than 112 min. Sufficient bedding must be provided so that it stays dry.

Table 5-4. Recommended dimensions of transportation accommodations for horses and ponies used in agricultural research and teaching

Trailer or van dimension	(m)	(ft)
Ceiling for horse height		
Up to 1.5 m (15 hands[1])	1.7–2.0	5.6–6.5
1.5–1.6 m (15 to 16 hands)	2.0–2.2	6.5–7.0
Width		
Single or tandem	1.2	4
	1.7–2 ×	5.6–6.6 ×
Two horses abreast	1.8–3.1	5.9–10.2

[1]One hand is about 10 cm (4 in).

Vehicle Recommendations

Truck beds for livestock transport should be clean, dry, and equipped with a well-bedded, nonslippery floor. Animals should be loaded and unloaded easily and promptly. Chutes should be well designed for the animals being handled (Grandin, 1990). Animals should be transported at appropriate densities to reduce the chances of injury. The type of transport vehicle is also important with regard to differences between and within species of livestock. For example, depending on breed type, horses often have special transport requirements (Houpt, 2007). Livestock should not be transported on trucks that do not have sufficient clearance to accommodate their height, as would be the case for horses transported on doubled-decked cattle trucks (Grandin et al., 1999; Stull, 1999; Houpt, 2007).

Many teaching and research activities require the frequent transport of animals for short distances. Careful loading and unloading will reduce stress. On short trips, loading and unloading is the most stressful part of the journey. On short trips, pigs remain standing (Guise et al., 1998) and they can be stocked at a higher density than on longer trips where the animals will need more space to lie down. For heavy (129-kg) pigs, increasing the floor spaces from 0.39 to 0.48 m2/pig reduced transport deaths from 0.88 to 0.36% on trips lasting approximately 3 h (Ritter et al., 2006). Vehicles should be of adequate size and strength for the animals carried and have adequate ventilation. Stock trailers and pickup truck beds fitted with stock racks are the most frequently used vehicles for short-distance transport. The inside walls and lining of the vehicles should have no sharp edges or protrusions that would be likely to cause injury. Animals may be transported either loose in these vehicles or may be haltered and tied in the case of cattle, sheep, and horses. Only animals that have been previously trained to a halter and that are of a quiet disposition should be tied when transported. Animals should be tied with a quick-release knot to the side of the vehicle at a height that is approximately even with the top of the shoulder (withers). The tie should be short enough so that animals cannot step over the lead.

The condition of the animals should be checked periodically during transit. Drivers should start and stop the vehicle smoothly and slow down for curves and corners.

Loading and Unloading Ramps for Livestock

A ramp is not required when the animals are transported in a low stock trailer. A well-maintained ramp with a nonslip surface is essential for loading animals onto trucks with beds taller than an animal's ability to step up onto the vehicle. Loading ramps must provide nonslip footing to prevent slipping and falling or damage to the dew claws (van Putten and Elshof, 1978; Grandin, 1983, 1990, 2007b; Phillips et al., 1988). On concrete ramps, stair steps provide good footing (Grandin, 1990). For cattle, each step should be 10 cm (4 in) high with a 30 cm (12 in) tread width. For all species, if the animals are not completely tame, the ramp should have solid sides.

Horse Transport

The typical vehicles designed to transport horses by road are vans, trailers, and trucks. The capacity of these vehicles ranges from transporting a single horse or multiple horses. During transportation, attempts should be made to minimize the trauma and anxiety of the horse. Considerations include the loading procedures, manner of driving, interior space, footing, ventilation, noise, lighting, duration of transit, mixing of unfamiliar or aggressive horses, fitness to travel, and handling (Grandin et al., 1999).

Horses are sometimes transported in small groups, and sorting horses for compatibility is important to minimize stress and injuries. Considerations for sorting may include size, sex, and behavior. Horses should not be placed in double-deck conveyances designed for cattle because these trailers are too limited in the height from floor to ceiling for most horses and injuries are prevalent (Grandin et al., 1999; Stull, 1999). All vehicles should be examined before each trip for safety and maintenance. The floor planking and metal floor braces should be of sufficient strength to bear twice the weight of any horse being transported. Door latches, tiers, and hitches should be inspected before the start of the trip and repaired if needed because these deteriorate with use and exposure.

Trailers. The required dimensions of a trailer depend on the size of the horses being hauled (Table 5-4). Horse trailers with individual stalls should have a butt chain or bar to prevent the exiting of a horse from the trailer. The rear doors may either be hinged (horse steps up into the trailer) or have a loading ramp, or both, with a strong fastening device to prevent the doors from opening during transit. In horse vans, full, solid partitions are often used between horses to form small box stalls. A partial partition located at the height of the middle of the horse's body should be used to separate horses in trailers and between cross-tied horses in vans. These partial partitions allow the horse to spread its legs enough to achieve proper balance in a limited area. The flooring should not be slippery. Sand, bedding, or rubber matting may provide better footing, which reduces anxiety and potential injuries. Legs wraps, tail wraps, bell boots, or padded halters are not necessary, but may be beneficial in preventing or minimizing injuries for some horses during transit. Lighting at night in the trailer and loading areas facilitates safe handling and loading of horses.

Table 5-5. Space requirements for lairage[1]

Species	Weight, kg (lb)	Space, m^2 (ft^2)
Cattle	545 (1,200)	1.87 (20)
Pigs (market weight)	113 (250)	0.55 (6)

[1]Further information on the design of lairage facilities and welfare at the slaughter plant can be found in the American Meat Institute Recommended Animal Handling Guidelines and Audit Guide (Grandin, 2007c,d).

Horses traveling together in small groups are usually not tied during transport and may exhibit limited movement depending on the loading density within the compartment. Excessive movement of horses during transit may indicate a problem and should be assessed by the driver. Horses in trailers and vans may be tied in transit to prevent turning around and interaction with other horses and should be tied using either a quick-release knot or panic-snaps. Tying horses limits the movement of the head and neck. The elevation of the horse's head above the withers during transit compromises the immune system and may predispose the horse to respiratory disorders (Raidal et al., 1997). Respiratory problems can be avoided by ensuring the head is not elevated above the point of the shoulder at least every 12 h, usually by feeding hay below chest level during transit or by taking breaks to allow the horse to lower its head (Racklyeft and Love, 1990; Stull and Rodiek, 2002).

Horses may need to be watered during the trip, preferably every 12 h and more often during hot weather conditions. Many horses traveling in trailers or vans are provided with hay while in transit. Horses without access to feed during transit should be fed at least every 24 h. Horses should not be expected to travel more than 24 h at one time without experiencing fatigue and dehydration, especially in extreme (hot or cold) environmental conditions (Stull, 1999; Friend, 2000b; Stull and Rodiek, 2002).

Regulation of air movement through the transport vehicle is essential to avoid thermal stress or excessive exposure to exhaust fumes. Adequate ventilation is especially crucial during extremely hot or cold weather. In hot weather, horses should not be left in parked trailers because heat stroke is likely; in cold weather, horses in moving trailers may need to be provided with

blankets, especially if air flow cannot be controlled (as in stock trailers that are not fully loaded).

Poultry Transport

Unlike the loading ramp and chute system used for livestock, poultry on commercial farms are caught manually and loaded into transport crates that are then stacked on an open bed truck. Special attention to developing skilled staff for the catching, loading, and transport of poultry is important. Increased fear (Jones, 1992), leg breakage (Gregory and Wilkins, 1989), and mortality have been associated with poor catching and loading techniques (Weeks, 2007). Also, poorly feathered birds have greater body heat loss than well-feathered birds. The thermal neutral zone ranges from 8 to 18°C and 24 to 28°C for well-feathered chickens and poorly feathered chickens, respectively, under typical transit conditions of low air movement and high humidity (Webster et al., 1992). Increased time in transit, feed and water deprivation, and fatigue can cause increased death loss and stress. Therefore, these factors should be minimized.

Transport Distance and Duration

Most of the animals transported for use in research and teaching will be transported short distances for durations less than 6 h. In these situations, the amount of time on a transport vehicle does not become a welfare issue. A high percentage of the animals will be transported for less than 2 h. United States regulations specify that livestock have to be unloaded, fed, and watered after 28 h on a vehicle without food or water during interstate transport. The US *Humane Slaughter Act* requires that livestock in the lairage (stockyards) of a slaughter plant must have access to water in all of the holding pens. People who use agricultural animals in research and teaching need to keep the time that livestock or poultry are on vehicles as short as possible. There may be situations where research has to be conducted on a commercial farm, feedlot, or slaughterhouse when the researcher has no control over the transport conditions.

Regulatory Requirements for Transport

Transporters must comply with all county, state, and federal animal health regulations and identification requirements before transporting livestock and poultry. When animals are transported across state lines or from foreign countries, federal regulations for vaccinations, veterinary inspections, and health certificates must be complied with. There are different regulations for each species, and each state may also have regulations for health certificates. State animal health laws apply to all animals transported within a state. Some western states have brand inspection laws that require certificates of ownership and inspection of the livestock by an inspector. In some states animals transported short distances must have certificates. Transporters should be knowledgeable of regulatory requirements. International regulations for transporting animals have recently been summarized (ILAR Transportation Guide, 2006).

Lairage Recommendations Before Slaughter

After the animals are unloaded from the transport vehicle, lairage pens should be provided. There must be sufficient space for all of the animals to lie down at the same time without being on top of each other. Table 5-5 lists some examples of recommended space requirements (Grandin, 2007c).

Emergency Procedures for the Research Facility and Transporters

Both research facilities and people transporting animals should have a list of emergency contact phone numbers. The following numbers should be on the list. For the contacts other than the police, fire, and ambulance, phone numbers for work, home, and mobile should be listed.

- Police (telephone number)
- Fire (telephone number)
- Ambulance (telephone number)
- Emergency contact 1 and emergency contact 2

Transporters should have numbers they can call if they have an accident. Some of the contacts that should be included are persons who can bring portable panels, loading ramps, or other equipment for reloading escaped animals after an accident.

REFERENCES

Abbott, T. A., E. J. Hunter, J. H. Guise, and R. H. C. Penny. 1997. The effect of experience of handling on pig's willingness to move. Appl. Anim. Behav. Sci. 54:371–375.

Albright, J. L. 1995. Flooring in dairy cattle facilities. In Animal Behavior and the Design of Livestock and Poultry Systems, Publ. NRAES-84, Ithaca, NY.

Albright, J. L., and C. W. Arave. 1997. The Behavior of Cattle. CAB International, Wallingford, UK.

Albright, J. L., and W. K. Fulwider. 2007. Dairy cattle behavior facilities, handling transport, automation and well being. Pages 109–133 in Livestock Handling and Transport. 3rd ed. In T. Grandin, ed. CABI International, Wallingford, UK.

American Sheep Industry Association. 2002. Pages 301–337 in Sheep Production Handbook. Vol. 7. Am. Sheep Ind. Assoc., Centennial, CO.

Ames, D. R. 1974. Sound stress and meat animals. Page 324 in Proceedings of the International Livestock Environment Symposium, SP-0174. American Society of Agricultural Engineers, St. Joseph, MI.

Apple, J. K., J. E. Minton, K. M. Parsons, and J. A. Unruh. 1993. Influence of repeated restraint and isolation stress an electrolyte administration on pituitary secretions, electrolytes, and blood constituents of sheep. J. Anim. Sci. 71:71–77.

Arnold, G. W. 1977. An analysis of spatial leadership in a small field in a small flock of sheep. Appl. Anim. Ethol. 3:263–270.

AVMA. 2007. AVMA Guidelines on Euthanasia, accessed October 4, 2007, http://www.avma.org/issues/animal_welfare/euthanasia.pdf

Barber, A., and R. B. Freeman. 2007. Design of sheep yards and shearing sheds. Pages 175–183 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Barnett, J. L., P. H. Hemsworth, and E. A. Newman. 1992. Fear of humans and its relationships with productivity in laying hens at commercial farms. Br. Poult. Sci. 33:699–710.

Battaglia, R. A. 1998. Handbook of Livestock Management Techniques. 3rd ed. Prentice-Hall, Upper Saddle River, New Jersey.

Benjamin, M. E., H. W. Gonyou, D. L. Ivers, L. F. Richardson, D. J. Jones, J. R. Wagner, R. Seneriz, and D. F. Anderson. 2001. Effect of handling method on the incidence of stress response in market swine in a model system. J. Anim. Sci. 79(Suppl. 1):279. (Abstr.)

Boandl, K. E., J. E. Wohlt, and R. V. Carsia. 1989. Effect of handling, administration of a local anesthetic and electrical dehorning on plasma cortisol in Holstein calves. J. Dairy Sci. 72:2193–2197.

Brundige, L., T. Okeas, M. Doumit, and A. J. Zanella. 1998. Leading techniques and their effect on behavior and physiological responses of market pigs. J. Anim. Sci. 76(Suppl. 1):99. (Abstr.)

Cockram, M. 2007. Sheep transport. Pages 184–198 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Cockram, M. S., J. E. Kent, P. J. Goddard, N. K. Waran, I. M. McGilp, R. E. Jackson, G. M. Muwanga, and S. Prytherch. 1996. Effect of space allowance during transport on the behavioral and physiological responses of lambs during and after transport. Anim. Sci. 62:461–477.

Coleman, G. J., M. McGregory, P. H. Hemsworth, J. Boyce, and S. Dowlings. 2003. The relationship between beliefs, attitudes, and observed behaviors in abattoir personnel in the pig industry. Appl. Anim. Behav. Sci. 82:189–200.

Cote, S. 2003. Stockmanship: A Powerful Tool for Grazing Management. USDA Natural Resources Conservation Service, Arco, ID.

Cregier, S. E. 1982. Reducing equine hauling stress: A review. J. Equine Vet. Sci. 2:187–198.

Curley, K. O., J. C. Pasqual, T. H. Welsh, and R. D. Randel. 2006. Technical note: Exit velocity as a measure of cattle temperament is repeatable and associated with serum concentration of cortisol in Brahman bulls. J. Anim. Sci. 84:3100–3103.

de Passillé, A. M., J. Rushen, J. Laewig, and C. Petherick. 1996. Dairy calves discrimination of people based on previous handling. J. Anim. Sci. 74:969–974.

Dumont, B., A. Boissey, and C. Archard. 2005. Consistency of order in spontaneous group movements allows the measurement of leadership in a group of grazing heifers. Appl. Anim. Behav. Sci. 95:55–66.

Dunn, C. S. 1990. Stress reactions of cattle undergoing ritual slaughter using two methods of restraint. Vet. Rec. 126:522–525.

Eicher, S. D. 2001. Transportation of cattle in the dairy industry: Current research and future directions. J. Dairy Sci. 84(E Suppl.):E19–E23.

Eldridge, G. A., C. G. Winfield, and D. J. Cahill. 1988. Responses of cattle to different space allowances, pens sizes, and road conditions during transport. Aust. J. Exp. Agric. 28:155–159.

Ewbank, R. 1968. The behavior of animals in restraint. Pages 159–178 in Abnormal Behavior in Animals. M. W. Fox, ed. W. B. Saunders, Philadelphia, PA.

Fike, K., and M. F. Spire. 2006. Transportation of Cattle. Vet. Clin. North Am. Food Anim. Pract. 22:305–320.

Fordyce, G. 1987. Weaner training. Queensland Agric. J. 113:323–324.

Friend, T. H. 2000a. A review of recent research on the transportation of horses. J. Anim. Sci. 79(E Suppl.):E32–E40.

Friend, T. H. 2000b. Dehydration, stress, and water consumption of horses during long-distance commercial transport. J. Anim. Sci. 78:2568–2580.

Geverink, N. A., A. Kappers, E. van de Burgwal, E. Lambooij, J. H. Blokhuis, and V. M. Wiegant. 1998. Effects of regular moving and handling on the behavioral and physiological responses of pigs to pre-slaughter treatment and consequences for meat quality. J. Anim. Sci. 76:2080–2085.

Grandin, T. 1980a. Livestock behavior as related to handling facilities design. Int. J. Study Anim. Probl. 1:33–52.

Grandin, T. 1980b. Observations of cattle behavior applied to the design of cattle handling facilities. Appl. Anim. Ethol. 6:9–31.

Grandin, T. 1980c. Bruises and carcass damage. Int. J. Study Anim. Probl. 1:121–137.

Grandin, T. 1981. Livestock Trucking Guide. Livestock Conservation Institute, Bowling Green, KY.

Grandin, T. 1982–1983. Pig behaviour studies applied to slaughterplant design. Appl. Anim. Ethol. 9:141–151.

Grandin, T. 1983. Welfare requirements of handling facilities. Pages 137–149 in Farm Animal Housing and Welfare. S. H. Baxter, M. R. Baxter, and J. A. D. MacCormack, ed. Martinus Nijoff, Boston, MA.

Grandin, T. 1987. Animal handling. In Farm Animal Behavior. E. O. Price, ed. Vet. Clin. North Am. Food Anim. Pract. 3:323–338.

Grandin, T. 1989a. Voluntary acceptance of restraint by sheep. Appl. Anim. Behav. Sci. 23:257.

Grandin, T. 1989b. Behavioral principles of livestock handling. Prof. Anim. Sci. 5:1–11.

Grandin, T. 1990. Design of loading facilities and holding pens. Appl. Anim. Behav. Sci. 18:187–201.

Grandin, T. 1992. Observation of cattle restrainer devices for stunning and slaughtering. Anim. Welf. 1:85–91.

Grandin, T. 1993. Behavioral agitation during handling of cattle is persistent over time. Appl. Anim. Behav. Sci. 36:1–9.

Grandin, T. 1996. Factors that impede animal movement at slaughter plants. J. Am. Vet. Med. Assoc. 209:757–759.

Grandin, T. 1997a. Assessment of stress during handling and transport. J. Anim. Sci. 75:249–257.

Grandin, T. 1997b. The design and construction of handling facilities for cattle. Livest. Prod. Sci. 49:103–119.

Grandin, T. 1998. Handling methods and facilities to reduce stress on cattle. Vet. Clin. North Am. Food Anim. Pract. 14:325–341.

Grandin, T. 2001. Cattle vocalizations are associated with handling at equipment problems in beef slaughter plants. Appl. Anim. Behav. Sci. 71:191–201.

Grandin, T. 2005. Maintenance for good animal welfare standards in beef slaughter plants by use of auditing programs. J. Am. Vet. Med. Assoc. 226:370–373.

Grandin, T. 2007a. Behavioral principles of handling cattle and other grazing animals under extensive conditions. Pages 44–64 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Grandin, T. 2007b. Handling facilities and restraint of range cattle. Pages 90-108 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Grandin, T. 2007c. Recommended Animal Handling Guidelines and Audit Guide. 2007 ed. American Meat Institute Foundation, Washington, DC. www.animalhandling.org

Grandin, T. 2007d. Handling and welfare of livestock in slaughter plants. Pages 329–353in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Grandin, T., S. E. Curtis, T. M. Widowski, and J. C. Thurman. 1986. Electro-immobilization versus mechanical restraint in an avoid-avoid choice test for ewes. J. Anim. Sci. 62:1469–1480.

Grandin, T., and M. Deesing. 2008. Humane Livestock Handling. Storey Publishing, North Adams, MA.

Grandin, T., and C. Johnson. 2005. Animals in Translation. Scribner, New York, NY.

Grandin, T., K. McGee, and J. L. Lanier. 1999. Prevalence of severe welfare problems in horse that arrives at slaughter plants. J. Am. Vet. Med. Assoc. 214:1531–1533.

Gregory, N. G., and L. J. Wilkins. 1989. Broken bones in domestic fowls handling and processing damage in end of lay battery hens. Br. Poult. Sci. 30:555–562.

Gregory, N. G., L. J. Wilkins, D. M. Alvey, and S. A. Tucker. 1993. Effect of catching method and lighting intensity on the prevalence of broken bones and on the ease of handling of end-of-lay hens. Vet. Rec. 132:127–129.

Gross, W. B., and P. B. Siegel. 1982a. Influence or sequences or environmental factors on the response of chickens to fasting and to Staphylococcus aureus infection. Am. J. Vet. Res. 43:137–139.

Gross, W. B., and P. B. Siegel. 1982b. Socialization as a factor in resistance to infection, feed efficiency, and response to antigen in chickens. Am. J. Vet. Res. 43:2010–2012.

Gross, W. B., and P. B. Siegel. 2007. General principles of stress and welfare. Pages 19–29 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Guise, H. J., H. L. Riches, B. J. Hunter, T. A. Jones, P. D. Warriss, and P. J. Kettlewell. 1998. The effect of stocking density on transit on carcass quality and welfare of slaughter pigs. Meat Sci. 50:439–446.

Heffner, R. S., and H. E. Heffner. 1983. Hearing in large mammals: Horse (*Equus caballus*) and cattle (*Bos taurus*). Behav. Neurosci. 97:299–309.

Hemsworth, P. H. 1981. The influence of handling by humans on the behavior, growth and corticosteroids in the juvenile female pig. Horm. Behav. 15:396–403.

Hemsworth, P. H., G. J. Coleman, J. L. Barnett, and S. Borg. 2000. Relationships between human-animal interactions and productivity of commercial dairy cows. J. Anim. Sci. 78:2821–2831.

Hemsworth, P. H., H. W. Gonyou, and P. J. Dzuik. 1986. Human communication with pigs. The behavioral response to specific human signals. Appl. Anim. Behav. Sci. 15:45–54.

Houpt, K. 2007. Horse transport. Pages 245–270 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Hutson, G. D. 1980. Visual field, restricted vision and sheep movement through laneways. Appl. Anim. Ethol. 6:175–187.

Hutson, G. D. 1981. Sheep movement on slatted floors. Aust. J. Exp. Agric. Anim. Husb. 21:474–479.

Hutson, G. D. 1982. Flight distance in Merino sheep. Anim. Prod. 35:231–235.

Hutson, G. D. 1985. The influence of barley feed rewards on sheep movement through a handling system. Appl. Anim. Behav. Sci. 14:263–273.

Hutson, G. D. 2007. Behavioural principles of sheep handling. Pages 155–174 in Livestock Handling and Transport. T. Grandin, ed. CABI Publishing, Wallingford, UK.

ILAR Transportation Guide. 2006. Guidelines for the Humane Transportation of Research Animals. Natl. Acad. Press, Washington, DC.

Jacobs, G. H., J. F. Deegan, and J. Neitz. 1998. Photo pigment basis for dichromatic colour vision in cows, goats, and sheep. Vis. Neurosci. 15:581–584.

Jones, R. B. 1992. The nature of handling immediately prior to test affects tonic immobility fear reactions in laying hens and broilers. Appl. Anim. Behav. Sci. 34:247–254.

Jones, R. B., and B. O. Hughes. 1981. Effects of regular handling on growth in male and female chicks of broiler and layer strains. Br. Poult. Sci. 22:461–465.

Jones, R. B., D. G. Satterlee, and G. G. Cadd. 1998. Struggling responses of broiler chickens shackled in groups on a moving line: Effects of light intensity hoods and curtains. Appl. Anim. Behav. Sci. 38:341–352.

Kannan, G., and J. A. Mench. 1996. Influence of different handling methods and creating periods on plasma corticosterone concentrations in broilers. Br. Poult. 37:21–31.

Kilgour, R. 1971. Animal handing in works: Pertinent behaviour studies. Pages 9–12 in Proc.13th Meat Industry Research Conf., Hamilton, New Zealand.

Kilgour, R., and C. Dalton. 1984. Livestock Behavior: A Practical Guide. Westview Press, Boulder, CO.

King, D. A., C. E. Schuchle-Pletter, R. Randel, T. H. Welsh, R. A. Oliphant, and B. E. Baird. 2006. Influence of animal temperament and stress responsiveness on carcass quality and beef tenderness of feedlot cattle. Meat Sci. 74:546–556.

King, J. O. L. 1976. The influence of disturbances on milk production in cows. Vet. Rec. 98:41–42.

Knowles, T., and P. Warriss. 2007. Stress physiology during transport. Pages 312–328 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Knowles, T. G. 1999. A review of the road transport of cattle. Vet. Rec. 144:197–201.

Knowles, T. G., P. D. Warriss, S. N. Brown, and J. E. Edwards. 1998. The effects of stocking density during the road transport of lambs. Vet. Rec. 142:503–509.

Lambooy, E. 1985. Electro-anesthesia or electro-immobilization of calves, sheep and pigs by Feenix Stockstill. Vet. Q. 7:120–126.

Lambooy, E., and B. Engel. 1991. Transport of slaughter pigs by truck over a long distance: Some aspects for loading density and ventilation. Livest. Prod. Sci. 28:163–174.

Lanier, J. L., T. Grandin, R. Green, D. Avery, and K. McGee. 2000. The relationship between reaction to sudden intermittent movements and sounds to temperament. J. Anim. Sci. 78:1467–1474.

Lay, C., T. H. Friend, R. Randel, C. C. Bowers, K. K. Grissom, and O. C. Jenkins. 1992a. Behavioral and physiological effects of freeze and hot iron branding on crossbred cattle. J. Anim. Sci. 70:330–336.

Lay, D. C., T. H. Friend, C. C. Bowers, K. K. Grissom, and O. C. Jenkins. 1992b. A comparative physiological and behavioral study of freeze and hot iron branding using dairy cows. J. Anim. Sci. 70:1121–1125.

Lemmon, W. B., and G. H. Patterson. 1964. Depth perception in sheep: Effects of interrupting the mother-neonate bond. Science 145:835–836.

Lewis, P. D., and T. R. Morris. 2000. Poultry and coloured light. Worlds Poult. Sci. J. 56:189–207.

Lynch, J. J., and G. Alexander. 1973. Pages 371–400 in The Pastoral Industries of Australia. University Press, Sydney, Australia.

McGlone, J. J., R. McPherson, and D. L. Anderson. 2004. Case study: Moving devices for market-sized pigs: Efficacy of electric pro, board paddle or flag. Prof. Anim. Sci. 20:518–523.

McKinley, J., H. M. Buchanan-Smith, L. Bassett, and K. Morris. 2003. Training common marmosets (*Callithrix jacchus*) to cooperate during routine laboratory procedures: Ease of training and time investment. J. Anim. Welf. Sci. 6:209–220.

Mitchell, K., J. M. Stookey, D. K. Laturnar, J. M. Watts, D. B. Haley, and T. Huyde. 2004. The effects of blindfolding on behaviour and heart rate in beef cattle during restrainer. Appl. Anim. Behav. Sci. 85:233.

Muller, R., K. S. Schwartzkopf-Genswein, M. A. Shah, and M. A. G. von Keyserlink. 2008. Effect of neck injection and handler visibility on behavioral reactivity of beef steers. J. Anim. Sci. 86:1215–1222.

Murphy, C. J., C. J. Neitz, N. M. Hoever, and J. Neitz. 2001. Photopigment basis for chromatic color vision in the horse. J. Vis. 1:80–87.

National Cattlemens Beef Assoc. 2007. Guidelines for the Care and Handling of Beef Cattle, Englewood, Colorado.

National Pork Board. 2008. Transport Quality Assurance (TQA) Handbook. Natl. Pork Board, Des Moines, Iowa.

Pajor, E. A., J. Rushen, and A. M. B. dePassillé. 2003. Dairy cattle choice of handling treatments in a Y maze. Appl. Anim. Behav. Sci. 80:93–107.

Panepinto, L. M. 1983. A comfortable minimum stress method of restraint for Yucatan miniature swine. Lab. Anim. Sci. 33:95–97.

Pascoe, P. J., and W. N. McDonnell. 1985. Aversive conditions used to test the humaneness of a commercial electroimmobilization unit in cattle. Vet. Surg. 14:75. (Abstr.)

Phillips, M., T. Grandin, W. Graffam, N. A. Irlbeck, and R. C. Cambre. 1998. Crate conditioning of Bonge (*Tragelephus eurycerus*)

for veterinary and husbandry procedures at Denver Zoological Gardens. Zoo Biol. 17:25–32.

Phillips, P. A., B. K. Thompson, and D. Fraser. 1988. Preference tests of ramp designs for young pigs. Can. J. Anim. Sci. 68:41–48.

Pollard, J. C., and R. P. Littlejohn. 1994. Behavioral effects of light conditions on red deer in holding pens. Appl. Anim. Behav. Sci. 41:127–134.

Prescott, N. B., and C. M. Wathes. 1999. Spectral sensitivity of domestic fowl (*Gallus g. domesticus*). Br. Poult. J. 40:332–339.

Price, E. O., and S. J. R. Wallach. 1990. Physical isolation of hand reared Hereford bulls increases their aggressiveness towards humans. Appl. Anim. Behav. Sci. 27:263–267.

Prince, J. H. 1970. The eye and vision. Pages 696–712 in Duke's Physiological of Domestic Animals. M. J. Swenson, ed. Cornell University Press, New York, NY.

Racklyeft, D. J., and D. N. Love. 1990. Influence of head posture on the respiratory tract of healthy horses. Aust. Vet. J. 67:402–405.

Raidal, S. L., G. D. Bailey, and D. N. Love. 1997. Effect of transportation on lower respiratory tract contamination and peripheral blood neutrophil function. Aust. Vet. J. 75:433–438.

Rennie, J. S., R. H. Fleming, H. A. McCormack, C. C. McCorquodale, and C. C. Whitehead. 1997. Studies on effects of nutritional factors on bone structure and osteoporosis in laying hens. Br. Poult. Sci. 38:417–424.

Ritter, M. J., M. Ellis, J. Brinkman, J. M. DeDecker, K. K. Keffaber, M. E. Kocher, B. A. Peterson, J. M. Schlipf, and B. F. Wolter. 2006. Effect of floor space during transport of market-weight pigs on the incidence of transport losses at the packing plant and the relationships between transport conditions and losses. J. Anim. Sci. 84:2856–2864.

Ritter, M. J., M. Ellis, D. B. Anderson, S. E. Curtis, K. K. Keffaber, J. Killefer, F. K. McKeith, C. M. Murphy, and B. A. Peterson. 2009. Effects of multiple concurrent stressor on rectal temperature, blood acid base status, and longissimus muscle glycolytic potential in market weight pigs. J. Anim. Sci. 87:351–362.

Robertshaw, D. 2004. Temperature regulation and the thermal environment. In Duke's Physiology of Domestic Animals. 12th ed. W. O. Reese, ed. Cornell University Press, Ithaca, NY.

Rushen, J. 1986. Aversion of sheep to electro-immobilization and physical restraint. Appl. Anim. Behav. Sci. 15:315–324.

Schapiro, S. J., J. E. Perlman, E. Thiele, and S. Lambeth. 2005. Training nonhuman primates to perform behavior useful in biomedical research. Lab Anim. (NY) 34:37–42.

Sheldon, C. C., T. Sonsthagen, and J. A. Topel. 2006. Animal Restraint for Veterinary Professionals. Mosby, St. Louis, MO.

Shulaw, W. P. 2005. Sheep Care Guide. American Sheep Industry Association, Centennial, CO.

Smith, B. 1998. Moving Em: A Guide to Low Stress Animal Handling. Graziers Hui, Kamuela, HI.

Stull, C. L. 1999. Responses of horses to trailer design, duration, and floor area during commercial transportation to slaughter. J. Anim. Sci. 77:2925–2933.

Stull, C. L., and A. V. Rodiek. 2002. Effects of cross-tying horses during 24 h of road transport. Equine Vet. J. 34:550–555.

Sutherland, M. A., P. J. Bryer, B. L. Davis, and J. J. McGlone. 2009. Space requirements of weaned pigs during 60 minute transport in summer. J. Anim. Sci. 87:363–370.

Swanson, J. C., and J. Morrow-Tesch. 2001. Cattle transport historical research and future perspectives. J. Anim. Sci. 84(E Suppl.):E19–E23.

Talling, J. C., N. K. Waran, C. M. Wathes, and J. A. an Lines. 1998. Sound avoidance domestic pigs depends on characteristics of the signal. Appl. Anim. Behav. Sci. 58:255–266.

Tanida, H., A. Miura, T. Tanaka, and T. Yoshimoto. 1996. Behavioral responses of piglets to darkness and shadows. Appl. Anim. Behav. Sci. 49:173–183.

Tarrant, P. V., F. J. Kenny, and D. Harrington. 1988. The effect of stocking density during 4 h transport to slaughter on behaviour, blood constituents and carcass bruising in Friesian steers. Meat Sci. 24:209–222.

Tarrant, P. V., F. J. Kenny, D. Harrington, and M. Murphy. 1992. Long distance transportation of steers to slaughter: Effect of stocking density on physiology, behaviour, and carcass quality. Livest. Prod. Sci. 30:223–238.

Tobin, T. 1981. Drugs and the Performance Horse. Charles C Thomas, Publisher, Springfield, IL.

Tulloh, N. M. 1961. Behavior of cattle in yards: II. A study of temperament. Anim. Behav. 9:25–30.

van Putten, G., and W. J. Elshof. 1978. Observations of the effects of transport on the well being and lean quality of slaughter pigs. Anim. Regul. Stud. 1:247–271.

Voisinet, B. D., T. Grandin, J. Tatum, S. F. O'Connor, and J. J. Struthers. 1997b. *Bos indicus*-cross feedlot cattle with excitable temperaments have tougher meat and a higher incidence of borderline dark cutters. Meat Sci. 46:367–377.

Voisinet, B. D., T. Grandin, J. D. Tatum, S. F. O'Connor, and J. J. Struthers. 1997a. Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. J. Anim. Sci. 75:892–896.

Warriss, P. 1998. Choosing appropriate space allowances for slaughter pigs transported by road: A review. Vet. Rec. 142:449–454.

Waynert, D. E., J. M. Stookey, J. M. Schwartzkopf-Gerwein, C. S. Watts, and C. S. Waltz. 1999. Response of beef cattle to noise during handling. Appl. Anim. Behav. Sci. 62:27–42.

Webster, A. B. 2004. Welfare implications of avian osteoporosis. Poult. Sci. 83:184–192.

Webster, A. T. F., A. Tuddenham, C. A. Saville, and C. A. Scott. 1992. Thermal stress on chickens in transit. Br. Poult. Sci. 34:267–277.

Weeks, C. A. 2007. Poultry handling and transport. Pages 295–311 in Livestock Handling and Transport. 3rd ed. T. Grandin, ed. CABI International, Wallingford, UK.

Whiting, T. I. 1999. Maximum loading density for loose horses. Can. J. Anim. Sci. 79:115–118.

Whiting, T. I., and S. Brandt. 2002. Minimum space allowances for transportation by swine by road. Can. Vet. J. 43:207–212.