General Session II

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Animal Welfare in Slaughter Plants

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Abstract

There are five basic causes of animal welfare problems in slaughter plants. They are: 1) Poorly designed or improper stunning and handling equipment. 2) Distractions which impede animal movement, such as sparkling reflections on a wet floor, air hissing, high-pitched noise or air drafts blowing down the race towards approaching animals. These distractions can ruin the performance of a well designed system and cause animals to become excited. When this happens, prodding will be required to make them move. 3) Lack of employee training and poor supervision of employees by management. 4) Poor maintenance of equipment and facilities, such as malfunctioning stunners or worn, slick floors which cause animals to slip and fall. 5) Poor condition of animals arriving at the plant, such as cripples and sick animals. Another problem is pigs and cattle from excitable genetic lines which are more likely to become agitated during handling. To maintain a high standard of welfare, all five problem areas must be addressed. A survey of 29 Canadian slaughter plants indicated that 27% had excellent non-slip floors and 21% had slick floors which would cause animals to slip. Twenty-four percent had high pitched motor noise or hissing air exhausts that caused animals to balk. Air drafts blowing down the race towards approaching animals were a problem in 9% of the plants. Air drafts will often impede animal movement.

Introduction

There are five basic causes of animal welfare problems in slaughter plants. They are: 1) stressful equipment and methods; 2) distractions that impede animal movement; 3) lack of employee training; 4) poor equipment maintenance; or 5) poor condition of the animals arriving at the plant. To correct an animal welfare problem, one has to determine the cause of it. For example, installation of new stunning equipment will not solve an abuse problem caused by untrained, poorly supervised employees or animal agitation caused by air hissing. This paper will review both the scientific literature and the author's observations in over 200 slaughter plants in the United States, Canada, Mexico, Europe, Australia and New Zealand. Surveys were conducted in plants in the U.S. and Canada to determine the incidence of distractions and equipment problems that impeded animal movement or caused animals to become excited. In the last section, the economic benefits of good animal welfare and public concerns will be covered.

Equipment and Methods

Equipment can be divided into two basic categories of stunning equipment and handling systems, such as races, lairages and restraint devices. There have been numerous research studies on stunning methods, but until recently, stress and discomfort during a lairage and movement of the animals to the stunning point was neglected. Ron Kilgour from New Zealand was the first researcher to discuss the need for greater emphasis on procedures that occur prior to stunning or slaughter (Kilgour, 1978).

Stunning

Effective stunning methods are readily available to induce instantaneous insensibility. Good reviews on captive bolt stunning can be found in Leach (1984),

Grandin (1994a) and Eikelenboom (1983). Electrical stunning methods used commercially on pigs and sheep are effective and induce instantaneous insensibility. A minimum of 1.25 amps must be passed through a pig's brain to reliably induce insensibility (Hoenderken, 1982). In sheep, 1 amp is required (Gregory and Wotton, 1984). Unlike pigs and sheep, a single current passed from the neck to the brisket failed to induce epileptiform changes in the electroencephalogram of cattle (Cook *et al.,* 1993). In cattle, a split stun procedure is used. A 2.5 amp current must first be applied to the head before a head-to-body current is applied (Gregory, 1993). Reviews by Warrington (1974), Leach (1985), Grandin (1985; 1986) and Gregory (1994) provide further information.

Carbon dioxide stunning is used for pigs in many countries. There have been welfare concerns about CO_2 because it is a pungent gas which is irritating to the respiratory tract (Gregory, 1994). Hoenderken (1982) reported that a motorific excitation phase occurs while the pig is still conscious. Forslid (1987) found that the excitation phase starts after the pig is unconscious in purebred Yorkshires. There is a large variation in a pig's reaction to CO_2 (Dodman, 1977; Grandin, 1988a). The reaction ranges from none when the pigs first sniff the gas, to violent attempts to escape. Halothane-positive pigs have more excitation (Troeger and Waltersdorf, 1991). Carbon dioxide stunning may be a good method for certain genetic types of pigs and very stressful to others.

Preslaughter handling

Good systems are available for handling cattle and sheep at the abattoir. Cattle and sheep will move quietly through single file races and ride quietly in a well designed conveyor restrainer system. Moving in single file is a natural behavior for cattle. In the U.S., large stunning boxes which held more than one bovine animal have been replaced with conveyor restrainers. The V conveyor restrainer was introduced for cattle in the 1970s (Schmidt, 1972; Willems and Markley, 1972). It was replaced in the 1990s with the center track double rail restrainer (Giger *et al.,* 1977; Grandin, 1988b; 1991). Cattle and sheep will remain calm in conveyors because they are touching the animal in front and behind them. V conveyors work less well for pigs. The author has observed that slender, lean pigs are not supported properly and heavily muscled pigs are pinched on the hams, whereas round, fat pigs are held in a comfortable position. Lean pigs are properly supported on a center track restrainer.

In England, head restraint devices are required by legislation to hold a bovine animal's head for captive bolt stunning. The purpose of the legislation was to improve stunning accuracy. In some circumstances, head restraint can increase stress. Ewbank *et al.* (1992) found that cortisol levels were higher in a head restraint compared to a conventional single animal stunning box. It took an average of 32 seconds to induce the cattle to put their heads in the poorly designed yoke used in this study. Stress can be minimal in a well designed head restraint where the animal is stunned immediately after the head is caught (Tume and Shaw, 1992; Frank Shaw, personal communication). The author has observed electrical stunning of cattle in a head restraint in New Zealand. Each animal quietly entered the stunning box and was stunned within 2 seconds after the head was clamped. Information on the design of head restraint devices can be found in CSIRO (1989) and Grandin (1993; 1994). Stress caused by prolonged restraint will be a severe problem if live animals are subjected to intravenous injections shortly prior to slaughter. Payne and Young (1995) reported that intravenous injections of lambs with antifreeze glycoproteins may improve the quality of frozen meat.

Design mistakes in races and forcing pens will cause stress. One of the most serious design mistakes is laying the race out so that its entrance appears to be a dead end. Cattle will move more easily through a curved race compared to a straight race, but it must be laid out correctly (Grandin, 1980; 1990; 1993). Practical experience has shown that an animal standing in the forcing pen must be able to see a minimum of two to three body lengths up the single file race before it curves. Bending the single file race too sharply where it joins the forcing pen will cause animals to balk.

Warris *et al.* (1994) found that pigs were more stressed in abattoirs with single file races compared to plants where pigs were stunned in small groups on the floor. The intensity of squealing was highly correlated with physiological stress measurements and PSE. Electrical stunning of pigs on the floor is most practical for abattoirs that slaughter under 240 pigs per hour. The author has observed that floor stunning often becomes rough and sloppy at higher speeds. In larger plants, a well designed race will produce less stress than a poor one. Weeding *et al.* (1993) found that both design and staff expertise affected stress levels in pigs.

Stress caused by forcing pigs to move through a single file race could be eliminated by stunning groups of pigs in CO_2 gas. Barton Gade *et al.* (1993) has developed a low stress driving and lairage system for moving groups of five pigs onto an elevator which descends into CO_2 gas. An entire system approach should be used for evaluating CO_2 stunning. Some discomfort during the induction of anesthesia may be a small price to pay for great reductions in handling stress.

PSE: - pale, soft and exudative

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Distractions That Impede Movement

Animals will often balk and stop moving through a handling system if there are distractions such as sparkling reflections, air blowing towards the animals, movement or high pitched noise. A survey of 33 Canadian slaughter operations ranging from small to the very largest revealed that cattle and pigs often balk and have to be prodded excessively due to distractions that can be easily eliminated (Table 1). These distractions will ruin the performance of well designed restrainers and races because animals often have to be prodded when they refuse to move. Sometimes, adding more light or moving a light to eliminate sparkling reflections on floors or walls will improve the movement of pigs or cattle. In two plants a new double rail conveyor system worked well when the plant was new, but balking at the restrainer entrance gradually worsened as the lamps over the restrainer grew dimmer with age. Animals have a tendency to move from a darker place to a more brightly illuminated place (Grandin, 1980; Van Putten and Elshoff, 1978). The light must not shine directly in the eyes of approaching animals.

Table 1. Incidence of Distractions Which Impede the Movement of Livestock in 33 Slaughter Systems[1]

Type of distraction	*Acceptable, move easily*	*Not acceptable, excessive balking*
Lighting problems (too dim or too bright)	28 (85%)	5 (15%)
Ventilation air blowing towards approaching animals	30 (91%)	3 (9%)
Seeing movement or sparking reflections	25 (76%)	8 (24%)
High pitched motor noise or hissing air exhausts	25 (76%)	8 (24%)

[1]Plants that slaughtered more than one species were tabulated as separate systems.

Air blowing through a stunning box entrance or down a race will make both pigs and cattle stop. Nine percent of the surveyed plants had serious balking problems caused by ventilation blowing air either out of the entrance of the stunning area or down a race. Seeing people moving up ahead or jiggling gates will also impede livestock movement. In one plant, cattle balked at a small chain jiggling in the race and, in another, cattle balked at a shiny reflection on a vibrating metal wall. When animals are calm, they will stop and look directly at things that make them balk.

In 24% of the plants visited, animals became visibly frightened by sudden air hissing noises or extremely high pitched noises. Observations by the author indicate that high pitched noise causes more agitation than a low pitched rumble of chains and gears. The ears of cattle are most sensitive at 8,000 Hz (Ames, 1974) and they can hear up to 21,000 Hz (Algers, 1984). Clanging and banging noises will make animals flinch or jump. Sheep slaughtered in a noisy commercial abattoir had higher cortisol levels than sheep slaughtered in a quiet research abattoir (Pearson *et al.*, 1977). The sudden noise of a door slamming and banging on a wall increased heart rate in deer (Price *et al.*, 1993). In the eight plants that had balking caused by noise, five were due to air hissing and three were due to high pitched motor noise. At one plant, elimination of a high pitched hydraulic whine resulted in calmer cattle. Stunning box entrance doors had hissing air in three plants. In one plant, installation silencers to stop hissing air resulted in a dramatic reduction of excited cattle. Other distractions which can impede movement are shadows, drain grates and changes of fencing or flooring types.

Employee Training and Supervision

During twenty years of experience, I have observed that plants which have good animal welfare have a manager who trains and supervises his or her employees. Plants with lax management often have animal abuse (Grandin, 1988c; 1994a). Maintaining a high standard of welfare requires constant management attention and vigilance. A good manager constantly works on improving details of procedures. After the distractions and serious design mistakes are eliminated, employees can fully use behavioral principles to move animals easily and quietly (Grandin, 1993; Kilgour and Dalton, 1984).

The author has observed that the most common mistake made by employees is attempting to move too many animals at a time. For all species, forcing pens should not be filled more than three-quarters full. Employees should also be taught how to time bunches of animals. The next bunch should not be driven into the forcing pen until there is space in the race for them to walk into. This procedure utilizes natural following behavior. Most important is that employees need to remain calm and avoid sudden, jerky motions or yelling. Electric prods should be used as little as possible.

Equipment Maintenance and Welfare

The two major maintenance problem areas that the author has observed are poor captive bolt stunner maintenance and slick floors. A survey of 29 Canadian slaughter plants indicated that 21% had slick floors (Table 2). The majority of slippery floor problems were due to either the rough finish wearing off a concrete floor or a slick floor in a cattle stunning box. The author has conducted welfare surveys in plants in both the U.S. and Canada. Slick floors which caused animals to fall down were the number one equipment problem. Cockram Corley (1991) found that slipping increased stress and also noted that it is a problem area.

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The author has observed that the second most common equipment maintenance problem in U.S. plants is poor maintenance of pneumatic captive bolt stunner. Stunners require careful maintenance to maintain maximum hitting power.

Table 2. Condition of Floors in Slaughter Plants

Number of slaughter systems	*Percentage*	*Flooring condition*
8	27%	Excellent, non-slip floor
15	52%	Acceptable floor
6	21%	Slick floor, not acceptable

Condition of Animals

Animals which arrive at the plant in bad condition often suffer. A recent survey of U.S. cow and bull slaughter plants indicated that 1% of the cull beef cows and 1.1% of the cull dairy cows arrive downed and unable to walk (Colorado State University, 1995). Most of these animals were in bad condition before they left the farm. Further information on death losses and metabolic stress can be found in Gregory (1994) and Grandin (1993). There have also been increasing problems with very excitable cattle and pigs which are more difficult to drive and more likely to become excited (Grandin, 1992; 1994b). The author has observed that the increase in excitable cattle and pigs appears to be in the leaner animals. This is an area that needs to be researched because the welfare of excitable animals is sometimes severely compromised.

Economic Advantages of Good Animal Welfare

Careful, quiet handling of livestock by trained people in good facilities will reduce bruising and help maintain meat quality. Bruises cost the U.S. beef industry $1.00 per animal on feedlot beef and $3.91 per animal on cows and bulls (Colorado State University, 1992; 1995). In Australia, bruises cost the beef industry $36 million annually (Blackshaw *et al.*, 1987). The U.S. pork industry loses 34¢ per pig due to PSE and 8¢ per pig due to bruises (National Pork Producers' Association, 1994). Improvements in pig handling and reductions or elimination of electric prods will reduce petechial hemorrhages (Calkins *et al.*, 1980). Improving animal welfare can also improve employee safety because calm cattle are less likely to run over employees or rear up.

Public Concerns

Treating animals in a humane manner is the right thing to do. The public is becoming increasingly concerned about how animals are treated. The treatment of downed, crippled animals has been an issue shown on national television in the U.S. and animal transport is a major issue in England. People unfamiliar with slaughter often ask, "Do animals know they are going to die" and "Are they afraid of blood?" Anil and McKinsey (1995) reported that pigs watching stunning and slaughter of another pig had little or no change in heart rate, cortisol or B endorphin levels. Observations made by the author indicate that the small distractions discussed previously are more likely to result in excitement or balking than seeing blood or watching another animal being stunned. Cattle will voluntarily walk into a restraint device that is covered with blood (Grandin, 1994a). The author has also observed that it appears that blood from relatively calm cattle has little effect, but if the animals become severely agitated for 10 or 15 minutes, possibly a fear pheromone is secreted. Other cattle will start balking and refuse to walk near the place where the previous animal was stressed. Research with rats and pigs indicates that there may be fear pheronomes in blood and urine. Urine from a stressed gilt caused other pigs to avoid a feed dispenser and urine from an unstressed animal had no effect (Vieville-Thomas and Signoret, 1992). Stevens and Saplikoski (1973) reported that blood and muscle tissue from stressed rats was avoided and brain tissue or water had no effect. Blood from guinea pigs and humans had little effect on rats (Hornbuckle and Beall, 1974; Stevens and Gerzog-Thomas, 1977).

Ritual Slaughter

Slaughter without stunning is an area of concern in many countries. When ritual slaughter is being evaluated from a welfare standpoint, the variable of restraint must be separated from the variable of the actual throat cut. In the U.S., some plants use highly stressful methods of restraint, such as shackling and hoisting fully conscious cattle by one back leg. Suspension of cattle by the back leg causes many animals to bellow and struggle, and their leg is sometimes broken. European and U.S. cattle are held in restraint devices that hold them in an upright position or in devices that invert them onto their backs (Grandin, 1994a; Grandin and Regenstein, 1994). The author has observed that cattle inverted onto their backs often aspirate blood, and stressful methods of restraint mask the animal's reaction to the throat cut.

Dunn (1990) found that inverting cattle onto their backs for 103 seconds caused the cortisol levels to be twice as high compared to cattle held in an upright restraint device. The use of devices that hold cattle in an upright position is now required in the United Kingdom. The author has observed that proper design and

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gentle operation of upright restraint devices can eliminate visible signs of animal discomfort, such as struggling. The restrainer must be equipped with pressure-limiting valves to prevent excessive pressure that would cause pain or discomfort from being applied to the animal's body (Grandin, 1994a). Parts of the apparatus which press against the animal should move slowly, because sudden, jerky motion tends to excite the animal. The throat cut should be made immediately after the head is restrained.

The animal's reaction to the throat cut can be observed when the animal is held in a comfortable, upright position. Most researchers agree that cutting the throat without stunning does not induce instantaneous unconsciousness (Daly *et al.*, 1988; Blackmore, 1984). In some cases, consciousness in calves can last for over a minute (Blackmore, 1984). Occlusion of the blood vessels will sometimes delay the drop in blood pressure which is required to induce unconsciousness (Anil *et al.*, 1995a).

Cattle have very little behavioral reaction to a correctly made kosher cut (shechitah) done with a razor-sharp long knife (Grandin, 1994a). Bager *et al.* (1984) made a similar observation. Behavioral observations and measurements are a major method of pain assessment (Short and Poznak, 1992). Halal slaughter done with hacking cuts with a short knife resulted in vigorous struggling and obvious distress (Grandin, 1994a). Allowing the incision to close back over the knife during the cut caused the animal to struggle, and excited cattle took longer to collapse. One can conclude that a correctly done cut is much less distressful than a poorly done cut.

Head-only electrical stunning is used in many halal slaughter plants on both sheep and cattle. Due to differences in the anatomy of the blood vessels in sheep compared to cattle, head-only stunning of cattle must be followed by a chest sticking method to ensure rapid loss of blood pressure (Anil *et al.*, 1995b). Minimizing stress and discomfort during ritual slaughter requires a skilled slaughterman and a well designed restraint device which holds the animal in a comfortable, upright position.

Conclusions

To maintain a high standard of welfare during handling and slaughter management, personnel in the abattoir must be attentive to details of the procedure and supervise and train employees. Lax management is a major cause of poor animal welfare. For good animal welfare, a plant must be equipped with well designed stunning and handling equipment which is kept well maintained by trained, conscientious employees. Small distractions that cause animals to balk and refuse to move through the system must be eliminated. Balking is often caused by sparkling reflections, air hissing, seeing people up ahead or drafts blowing down the race towards approaching animals.

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