

ANIMAL WELFARE AND HUMANE SLAUGHTER

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Summary

When captive bolt or electrical stunning is applied correctly it will instantaneously render the animal insensible to pain prior to slaughtering procedures. To render the animal instantly insensible with electrical stunning the current must pass through the brain. Carbon dioxide anesthesia of pigs does not cause instantaneous insensibility, but the onset of anesthesia is probably peaceful for certain genetic types of pigs and may be distressful to others. Concerns about animal welfare are increasing worldwide. The use of stunning to render animals insensible to pain is required in many industrialized countries. Proper application of the chosen stunning method will help prevent meat quality problems. Careful and calm handling of the animals will prevent bruises and maintain high meat quality. The ritual slaughter methods of Jews and Muslims are also discussed. To maintain good animal welfare, animals must be handled carefully and stunning equipment must be kept well maintained and be operated correctly. Stunning and slaughtering should be monitored at the following critical control points to maintain a high welfare standard, 1) stunning efficiency on the first attempt, 2) Insensibility on the bleed rail, 3) Percentage of animals that vocalize (moo, bellow, grunt or squeal) during handling and stunning, 4) Percentage prodded with an electrical goad and 5) Percentage that fall down. Animals that have been stunned correctly should not show any of the following signs of sensibility, righting reflex, eye blinking, rhythmic breathing, vocalization, corneal reflex or respond to a pinch. When hanging on the bleed rail the head should hang straight down and be limp and floppy. Movements of the limbs should be ignored.

1. Introduction

Concern for animal welfare is a major consideration in meat production and is based upon the belief that animals can suffer. Welfare may be considered in terms of the subjective experiences of animals (measured using behavioral testing) or in terms of biological functioning (measured using reactions to stress including plasma levels of stress hormones as well as heart rate and brain levels of neurotransmitters). Meat consumers are increasingly demanding that animals be reared, handled, transported and slaughtered using humane practices. Public pressure for increased protection and welfare of animals comes primarily from people in largely urbanized populations, is inversely related to the proportion of a population that is engaged in agriculture and is increasing in importance throughout the world. Concern about the welfare of animals is contingent on people believing that animals, if improperly cared for or mistreated, can experience pain and suffering.

The most important factor determining whether a slaughter plant has good or bad animal welfare practices is the attitude of management personnel. During the first author's 25-year career, she has observed that the plants that have good handling and stunning practices have a top manager who "cares" about animal welfare; as upper-management personnel change, handling and stunning improve or decline, depending largely upon the attitude of the new person. The best facilities and the latest technology make handling livestock easier but they do not make the manager; and until the owner or manager is convinced that proper handling practices pay off economically, it is unlikely that employees will follow procedures day-in and day-out. The manager that is most

effective in maintaining high humane standards is involved enough in day-to-day operations to know and care, but not so involved that he or she becomes numb and desensitized.

Below are some tips for handling pigs. (a) Pigs will follow other pigs, so it's best to move small groups of pigs rather than single pigs. (b) Large groups (more than 15 pigs) are more difficult to direct and move than several small groups. (c) Plan ahead to allow appropriate time and set the route before you begin, making sure there is only one way for the pigs to go. (d) Move pigs in a slow, steady and calm manner. (e) Use paddles and sorting panels to move pigs rather than using electric prods. (f) Use the animal's flight zone to your advantage; because pigs can see in a wide range on either side, solid walls keep the animal's focus in front. (f) Pigs will explore as they go; they will investigate unique lighting, smells, surfaces, sounds and other animals. (g) On farms, touching pigs every day is a good idea but make sure each experience is positive. (h) Some genetic types of pigs tend to be more fearful of humans than others; so, genetics (selection for calm, easy-going types) is important. Ultra lean hybrid pigs tend to display higher incidences of blood-splash and broken backs during slaughter and that those problems are especially evident in large, double-muscled pigs. Solving the problem will require changing genetics.

Some cattle handling systems work like well-oiled machines, while others bog down with cattle that constantly balk and turn around. There are usually three basic problems in crowd-pens and chutes: (a) Distractions, such as a chain hanging down in the chute entrance, that cause balking. (b) Poor handling methods, like overloading the crowd-pen with too many cattle. (c) Layout mistakes in the crowd-pen and chute.

When an animal welfare problem occurs in a plant, the cause of the problem must be determined. If the cause of the animal welfare problem is properly diagnosed, it will be easier to correct the problem. Critical to the process is identifying which of the following items is causing the problem: (1) Lack of supervision and training of employees. (2) Poor maintenance of stunning equipment, restraint systems, gates and other animal handling equipment (slick floors are a common maintenance problem). (3) Distractions that make animals balk and refuse to move (for example, inadequate lighting, air blowing toward approaching animals or animals being able to see people up ahead). (4) Condition of animals arriving at the plant. (It is difficult to humanely handle weak debilitated animals that are non-ambulatory. Pigs with an overly excitable temperament, that balk at minor things, create handling problems; these problems are often worse in very lean pigs. Producers should walk in their finishing pens and induce pigs to flow around them every day. This trains the pigs to quietly get up and move in the desired direction; only 10 or 15 seconds per pen per day, for the entire finishing period, is required to accomplish such training.) (5) Design problems with equipment. (Before going to the expense of changing equipment, items 1, 2, 3 and 4, above should be ruled-out as causes of the problem). A common design problem, that can create problems with animal handling, is a beef stunning box that is too wide.

Preslaughter stunning should render animals insensible to pain (unconscious) and that welfare perspectives have also made it imperative to ensure that animals do not suffer needlessly during slaughter; stunning methods must provide assurance that adverse

effects (blood-splash, fractures and PSE meat) are avoided. Scientists can look at EEG's (brainwaves) to determine if a stunning procedure induces insensibility (unconsciousness). Research at CSIRO in Australia used Fourier techniques to evaluate pre-stun and post-stun electroencephalograms (EEG) of adult cattle stunned with electricity or by use of a captive-bolt device and concluded that such procedure can be used to provide objective evidence of changes in the EEG signals following stunning to assess the effectiveness and humaneness of various stunning procedures.

When electric stunning is used an electric current is passed through the brain to induce instantaneous insensibility. When CO₂ stunning is used the pigs are lowered into a pit containing 90 percent CO₂ (carbon dioxide) gas. A captive bolt gun induces insensibility by shooting a steel bolt at high velocity into the brain. The bolt retracts and is reset for the next animal.

2. Comparisons of electrical stunning and CO₂ stunning

In the European Union, the Council Directive 93/119/C states that all animals destined for meat consumption must be rendered insensible instantaneously and remain insensitive to pain until there is a complete loss of brain responsiveness due to bleed out. This is the main concern when the suitability of a stunning method is analyzed from an animal welfare point of view. Internationally, the two most commonly used methods for commercial pre-slaughter stunning of pigs are electrical stunning and CO₂ anesthetization. CO₂ stunning is used more and more but electrical stunning is still widely used with the arguments for choice of method related to animal welfare and meat quality.

The physiological effect of the two most commonly used methods of pig stunning differs. CO₂ anesthetization results in a lowering of the blood pH (makes blood more acidic) which leads to loss of consciousness. The electric current used in electrical stunning produces an epileptiform activity in the brain leading to unconsciousness without a simultaneous lowering of the blood pH. Electrical stunning will, on the other hand, be followed by an acute fall of the muscle pH due to the powerful activation of the glycolysis in the muscles. Glycolysis is the process that a muscle uses to "burn" energy stored in its cells. Individual differences, among animals, in the stress response are important in welfare issues; slaughter poses particular problems and neurophysiology has provided objective criteria to assess the effectiveness of electrical stunning.

The current methods of stunning such as electric stunning and CO₂ exposure, are designed to induce physiological changes in the animal's brain so as to render it insensitive before slaughter. Both electrical stunning and CO₂ stunning lead to lowering of muscle pH and increase the rate of postmortem muscle glycolysis in pigs due to increased muscle activity. Low muscle pH and pork which drips water is associated with poor quality pork which is pale, soft and exudative (watery). This pork may have a quality defect called PSE. Dutch and German researchers found that PSE incidence increases after use of electrical stunning whereas CO₂ stunning reduces incidence of PSE pork.

Comparisons of unstunned/unrestrained slaughter to both electrical stunning and CO₂ stunning of pigs in Brazil concluded that: (a) Any stress placed upon pigs immediately before slaughter should be avoided. (b) The relatively high glycolytic rate of unstunned/unrestrained animals highlights the need for care in handling swine in the period immediately prior to slaughter. (c) Muscle pH was higher and water-holding capacity was most desirable when pigs were CO₂ stunned, intermediate when pigs were electrically stunned, and least desirable when pigs were unstunned/unrestrained. When electrical stunning and CO₂ stunning of market pigs were compared, it was found that for pigs with similar genetic background (free from the Halothane gene) and with the same environmental exposure prior to stunning, electrical stunning resulted in twice the drip loss from the *longissimus* (loin) muscle with the same muscle pH and meat color. The Halothane gene is a recessive genetic defect in pigs which causes meat quality problems. Pigs which inherit two copies of this gene from both the sire and the dam will often have heart failure when they become stressed. Pigs which inherit one copy of this gene from one parent often have more PSE than pigs which are free of the Halothane gene.

A survey of Spanish abattoirs found a significant abattoir effect on all indicators of effectiveness of stunning, whereas the stunning method had a significant effect only on the percentages of animals: (a) showing no corneal reflex or (b) showing either the absence of corneal reflex or the absence of rhythmic breathing were absent. Rhythmic breathing and a corneal reflex (response of the eye to touch) are indicators of return to sensibility. The proportion of animals that were unconscious and insensible was lower on exiting the CO₂ stunner than after electrical stunning (62 vs. 99 percent). The difference in the effectiveness of the two methods was probably due to equipment problems or poor management of CO₂ stunning. In well managed North American abattoirs using head to back cardiac arrest electric stunning less than 1 in 1,000 pigs exhibited a corneal reflex when cardiac arrest stunning is used where a 60 Hz electric current is passed through both the heart and the brain. Under commercial conditions, CO₂ stunning was less effective in terms of the rapid onset of insensibility in pigs which may have been due to the stop/start manual nature of the system which can lead to a certain variability in the time of exposure to the gas of the pigs in the different positions in the pit. After hoisting of the CO₂ stunned pigs, 13 percent in one plant and 33 percent in another plant had signs of recovery whereas the pigs stunned electrically did not show any signs of recovery on the bleeding rail. It was concluded that the administration of an electrical current with 220 volts and a frequency of 800 Hz spanning the brain, in combination with an electrical current with 110 volts and 50 Hz passing through the heart, was more effective than the CO₂ stunning system. The time of the exposure to the gas and the stun to stick interval must be regulated carefully in order to prevent the animals from regaining sensitivity after stun. Problems with return to sensibility can be eliminated by adequate time exposure to the gas. The differences in the efficiency of the two CO₂ stunnings evaluated underlines the importance of correct management of the system.

A survey of four commercial pig abattoirs was conducted, two of which used an automatic electrical stunning system through which pigs rode on a chest belt with an automatically applied, head only electrical stunner, followed by head-to-chest electrical stunner and the other two plants which used a CO₂ stunning unit filled with 83 percent

CO₂. There was a higher degree of muscle activity during the epileptic attack of electrically stunned pigs compared to gas-stunned pigs leading to a higher incidence of PSE meat in their carcasses. To induce unconsciousness, an electric stunner must induce a grand mal epileptic seizure similar to a person that has epilepsy. The results of several research studies showed an increased incidence (10 to 19 percent) of PSE in plants equipped with electrical stunning than in plants using CO₂ stunning (PSE incidence of 2 to 6 percent).

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Biographical Sketches

Temple Grandin is an Assistant Professor of Animal Science at Colorado State University. She teaches a class on cattle handling and facility design and designs livestock handling facilities at slaughter plants, feedlots and ranches. Half the cattle in North America are handled in a restrainer system that she designed.

She consults with the industry on stunning methods and animal handling and major meat companies in North America. The American Meat Institute guidelines for Good Management Practices for Animal Handling and Stunning were authored by Dr. Grandin.

Dr. Grandin received her Ph.D. at the University of Illinois and has received numerous industry awards. Some of her awards are American Meat Institute Industry Advancement Award 1994, Animal Management Award, American Society of Animal Sciences 1995 and the Forbes Award, National Meat Association 1998.

Dr. Grandin has authored over 400 articles and papers in both refereed journals and industry publications. She has also appeared on National TV shows such as Larry King Live CNN, 20/20, 48 Hours and the NBC Today Show.

Gary C. Smith occupied the Monfort Endowed Chair in Meat Science at Colorado State University in June of 1990. Previously, he served as a Professor (1969-1982) and Head (1982-1990) of the Department of Animal Science at Texas A&M University where he won the Outstanding Teaching Performance Award, the Honor Professor Award, the College of Agriculture Teaching Award, the University Distinguished Teaching Award and the Deputy Chancellor's Award for Team Research.

Gary has won both the Distinguished Research Award and the Distinguished Teaching Award from the American Society of Animal Science and from the American Meat Science Association. He was named one of the "25 Who Made a Difference" by *Beef* magazine. In 1993 he was named a University Distinguished Professor by Colorado State University and Fellow-in-Teaching by the American Society of Animal Science; in 1994 he was named one of six "Industry Innovators" by *Meat Marketing and Technology* magazine. In 1989 he was named a Distinguished Alumni by College of the Sequoias; in 1996 he received the Alumni Award of Excellence from California State University-Fresno. In 1997, he received the Meritorious Service Award from the Intercollegiate Meat Coaches Association of the American Meat Science Association and the Meat Industry Achievement Award from the American Meat Institute. In 1998, he was the recipient of the "Floyd Forbes Award" for service to the National Meat Association and one of the Secretariat of Agriculture of Argentina, Service (to cattle producers and meat packers) Recognition Award.

Smith's research interests include carcass evaluation and grading; composition, quality and palatability of red meat; red meat safety; and packaging and retailing of red meat. He has published 342 full-length articles in refereed scientific journals and more than 675 other contributions as proceedings, technical reports, etc. Gary served as president of the American Meat Science Association in 1976.