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### **Is slaughter by captive bolt more humane than halal style slaughter?**

In the United States, 35 million cattle were commercially slaughtered in 2011, and this number is only expected to increase (CDC, 2012). The four acceptable and humane slaughter methods accepted by the FDA to render animals insensible to pain before exsanguination include carbon dioxide, captive bolt, gunshot and electrical current (USDA-FSIS, 2012). Today, most meat produced in federally inspected plants in the U.S. is produced under the Humane Slaughter Act of 1978 (AMI, 2007). However, when Congress originally passed the law in 1958, it recognized that some of the law's requirements would conflict with the religious slaughter practices that are a part of Jewish and Muslim traditions. In response, the act acknowledged that kosher (Jewish) and halal (Muslim) slaughter can be performed humanely (AMI, 2007), and that slaughtering animals without stunning is acceptable in the U.S under these religious conditions.

There are a number of welfare issues relating to religious slaughter and the handling of animals both before slaughter and at point of slaughter (Grandin and Regenstein, 1994). Most notably perceived pain and distress by cattle during the neck cut and the duration of sensibility in the period after slaughter prior to loss of brain function are often examined within religious slaughter methods (Grandin and Regenstein, 1994; Anil et al., 2006). This paper will examine two different methods of the slaughter of cattle: penetrating captive bolt versus traditional halal slaughter. The two methods at point of slaughter will first be illustrated, and then pre-slaughter methods relating to the restraint of the animal prior to slaughter will be compared and contrasted. Ultimately, these comparisons will answer the question: is commercial captive bolt stunning

more humane than the practice of halal style slaughter? Several physiological indicators such as bleed-out rate, sentience at point of slaughter, and time to collapse among others will be examined and compared between the two methods.

The use of a captive bolt pistol is common in commercial pre-slaughter methods as it is versatile and can be appropriately and humanely used on sheep, goats, pigs, equids, and some exotic animals such as camels (Grandin and Chambers, 2001). The penetrating captive bolt pistol effectively causes the animal to lose consciousness by penetrating the skull with a pointed reloadable bolt, causing irreversible damage in the cerebrum and cerebellum (Grandin, 2002). Slaughter plants in the United States must be able to render 95% or more of the cattle as insensible to pain with a single captive bolt shot (Grandin, 2012). The penetrating captive bolt gun should be placed on the middle of the cattle's forehead (Grandin, 2010). Stunning operators should form an imaginary "X" between the inside edge of the eye and the base of the horns when placing the captive bolt gun (Grandin, 2010).

A stunning box is the most common method of restraining cattle before pre-slaughter methods such as captive bolt stunning (Grandin and Chambers, 2001). The size of the stunning box should be just wide enough to prevent the animal from turning around, and the floor should be made of a non-slip material (Grandin and Chambers, 2001). The stunning box resembles a conventional squeeze chute in which the cattle remain in a standing and upright position during slaughter. Grandin and Chambers (2001) contend that a basic stunning box should include a sliding entrance door, a side door parallel to the animal used to eject the unconscious animal after stunning, a floor with the ability to incline after stunning in order to facilitate ejection of the stunned animal, and a raised platform on the outside of the box for the operator to oversee the stunning process.

Religious slaughter remains a controversial issue among the general public, religious communities, veterinarians, government offices and welfare organizations. One of the main contentious points of the issue is whether or not to allow slaughter without pre-slaughter stunning (Anil et al., 2006). Regenstein et al. (2003) assert that most of the six to eight million Muslims in North America observe halal laws which utilize halal style slaughter, but the food industry has for the most part ignored this consumer group.

The Halal Food Authority describes the word 'halal' as being synonymous with permissible, and in further translation, is usually used as 'lawful'; Muslims cannot consume meat unless it has undergone halal style slaughter (HFA, 2012). Halal pre-slaughter methods and methods at point of slaughter differ from commercial slaughter techniques such as the penetrating captive bolt method in three ways.

First, several passages of the Qur'an are read to the animal prior to slaughter in order to honor the sacrifice and observe the importance which God has placed on the consumption of food (IFANCA, 2012). Second, the method at point of slaughter consists of a rapid and deep incision made across the width of the animal's neck with a razor sharp knife (Grandin and Regenstein, 1994; Meat & Livestock Australia, 2012). MLA believe that the knife used in ritual slaughter should ideally be twice the width of the neck so it can be drawn the across the neck without having the tip enter the wound. In addition to the severing of major blood vessels leading to and from the brain, a number of other tissues are severed by the extensive neck cut, including skin, muscle, trachea, oesophagus, sensory and motor nerves and connective tissue (MLA, 2012)

Third, the restraining methods used for religious slaughter techniques differ from restraining methods used in commercial slaughter methods (Gregory, 2004b). While six methods

of restraint during religious slaughter are currently accepted (Gregory, 2004b), Grandin and Regenstein (1994) strongly contend that an ASPCA approved restraining mechanism (also known as the ASPCA pen) is one of the most effective restraint methods because the animal's body, head and neck are stabilized and supported at point of slaughter. The ASPCA pen consists of a narrow stall with an opening in the front for the animal's head. The animal is supported by a regular squeeze chute mechanism, a belly lift, and a head lifting mechanism, both to support the animal's head and present the neck for the ritual cut (Grandin and Regenstein, 1994).

The welfare issues during slaughter without stunning include the stress of restraint, whether the cut is painful, and whether the animal experiences undue distress whilst it is bleeding out (Gregory, 2004b). Various physiological components have been examined in cattle in numerous studies to establish if the commercial captive bolt method is "more humane" than traditional halal style slaughter because of the stunning element which is absent in halal style slaughter. Gregory (2004a) has discussed the likely physiological events which occur when a neck is cut in a non-anaesthetized state. In summary, when the neck is cut with a knife there will be direct activation of neurons by the blade as it transects the nerves. This produces an intense but brief injury discharge in the afferent nerves of which serve a number of functions including registering pain, temperature change and distortion of the skin. Gregory (2004a) emphasizes that the sensation produced during the ritual cut are likely to be an amalgam of all such inputs, and the overall effect is likely to be a sense comparable to that of electric shock, although there is no reason to assume that one sensation (such as cold) could not override these sensations of pain.

One of the most keenly debated issues in religious slaughter is the bleed-out rate, which is claimed by those who support religious slaughter to be faster than when stunning is not used (Anil et al., 2006). In response to this claim, a study conducted by Anil et al. (2006) examined

and compared exsanguination volume and rate between 13 cattle that were rendered unconscious before bleed-out by penetrating captive bolt method to 13 cattle slaughtered by halal style methods. Animals subjected to captive bolt stunning lost an estimated 51.7% of their blood volume compared to 49.9% estimated blood loss for animals that were not stunned, bearing no significant difference between the two groups (Anil et al., 2006). However, Anil et al. (2006) confirmed that animals which were not stunned took significantly longer (17.3 seconds) to bleed out 25% of their total blood volume as compared to animals which had been stunned (10.6 seconds).

Gregory et al. (2008) contend that false aneurysms have a high likelihood of occurring during halal slaughter which could pose a risk of extended consciousness. False aneurysms are thought to develop when the severed carotid artery blood reacts within its surrounding connective tissue sheath, which seals the adventitia (or the outermost connective tissue of the artery), causing the tissue layer to fill with blood (Gregory et al., 2006). If bleeding is arrested in this way, blood can continue to flow to the brain (Gregory et al., 2012).

An additional study by Gregory et al. (2009b) indicates halal style slaughter methods can result in blood in the respiratory tract, which has the potential to cause suffering in cattle. The results indicated that cattle slaughtered by halal methods had a higher percentage of blood lining the trachea and upper bronchi when compared to cattle that had been stunned (Gregory et al., 2009b). The researchers concluded that concerns about suffering from airway irritation by blood could apply in animals that are either not stunned before slaughter or do not lose consciousness rapidly whilst blood is present in the respiratory tract.

Time for the animal to collapse after either captive bolt method or ritual slaughter is an indicator of sentience at point of slaughter (Gregory et al., 2009a). The reason for prolonged consciousness in some cattle is thought to be due to occlusion of the severed cardiac ends of the carotid arteries following ritual slaughter, which can be associated with prolonged consciousness following the cut (Gregory et al., 2009a). In a study conducted by Gregory et al. (2009a), 174 cattle were ritually slaughtered to establish the number of cattle which exhibited consciousness after the ritual cut was made. The results from Gregory et al. (2009a) indicated that 14% of cattle within the study exhibited phasic consciousness (or prolonged cycles of consciousness) after the cut had been made. This phasic consciousness was demonstrated by the collapse of several cattle as well as additional behaviors indicating awareness of the cut after release from the restraining device (Gregory et al., 2009a). 8% of the cattle within the study experienced consciousness for longer than a minute until final collapse, and 14% of the cattle collapsed and stood up again after release from the restraining device. It is likely that these animals were distressed (Gregory et al., 2009a).

Due to the fact that cattle experiencing penetrating captive bolt stunning have been knocked unconscious prior to exsanguination, it is assumed that animals killed by ritual slaughter practices are almost guaranteed to lose consciousness more slowly (Lambooji et al., 2010). Results accumulated by Lambooji et al. (2010) confirm there is a comparatively slow decrease of sentience after neck-cutting and a large decrease in sentience after captive bolt and electrical stunning. However, more comprehensive studies have been able to establish the rapidness of loss of brain function after both captive bolt method and religious style slaughter.

Several studies have been conducted to establish the time to brain failure between cattle stunned prior to exsanguination and cattle killed by ritual slaughter before exsanguination. Many

of these studies utilized an electroencephalogram (also known as EEG), which uses stainless steel electrodes to measure voltage fluctuations linked to evoked activity by the brain to investigate if responses to slaughter by ventral-neck incision without prior stunning may be perceived as painful by the cattle (Gibson et al., 2009a). The establishment of whether or not cattle respond to the neck cut as a form of noxious stimulation has produced conflicting results. In some cases, cattle lost brain function promptly (as assessed from spontaneous or evoked activity in the EEG), and there was little variation between individual animals that were slaughtered by captive bolt as opposed to those slaughtered by halal methods (Gregory and Wotton, 1984). However, Gibson et al. (2009a) contend that there is a period following slaughter where ventral-neck incision represents a noxious stimulus. Results from Gibson et al. (2009b) further support the conclusion that the EEG responses seen after ventral-neck incision in intact animals are primarily due to noxious stimulation as a result of incision of ventral-neck tissues and not mainly as a result of loss of blood flow through the brain (Gibson et al., 2009b).

In addition to measuring brain activity via EEG, electrodes are used to record electrical activity from the cerebral cortex by using an electrocorticogram or ECoG (Kalweit et al., 1989). In a study by Kalweit et al. (1989), the first trial illustrated that the interval until disappearance of cortical activity was prolonged in stunned animals, but was not significantly different in comparison to cattle which were slaughtered using halal methods. However, Kalweit et al. (1989), the results from the second trial of the study revealed shorter intervals until disappearance of cortical activities when using captive-bolt stunning. Ultimately, these researchers could not conclude if increased pain sensitivity occurred in the two groups of animals.

Comparison of penetrating captive bolt slaughter and halal style slaughter methods indicates that rendering an animal unconscious before exsanguination may be a necessity in slaughtering practices due to the number of uncomfortable side effects associated with the ritual cut in religious slaughter. As discussed, several studies indicate that the actual ritual cut is likely experienced as a noxious stimulus by the cattle, akin to the animal experiencing some sort of shock (Gregory, 2004a). Extensive results from Gibson et al.(2009a) based off of EEG readings also conclude that the period following the neck cut represents a noxious stimulus to the cattle and that the majority of the noxious stimulus stems from the incision made in the neck. Studies of time to collapse following the ritual cut (Gregory, 2009a) indicate a significant portion of the cattle slaughtered by ritual cut experienced waves of consciousness and stresses associated with falling and prolonged sentience during the bleed-out period.

Additionally, several studies illustrated that contrary to the belief of supporters of religious style slaughter, bleed-out rate was slower in cattle slaughtered by halal style methods (Anil et al., 2006). Several studies also indicated that false aneurysms and associated complications have the potential to extend consciousness (Gregory et al., 2008) and that cattle slaughtered by halal style methods could also experience breathing difficulty due to blood leakage in to the upper respiratory tract (Gregory et al., 2009b).

The research indicates that cattle welfare may be reduced at point of slaughter by the ritual neck cut component of halal slaughter in comparison to penetrating captive bolt slaughter methods which stresses a complete lack of sentience before exsanguination. The focus on eliminating sentience by use of a penetrating captive bolt pistol before exsanguination reduces the chance for cattle to experience the discomfort, pain and complications associated with the ritual neck cut at time of slaughter. Further, the results from current research examining halal

style slaughter methods suggests that current methods (specifically in response to the ritual neck cut) may need to be altered or that other methods which adhere to Muslim doctrine may need to be explored altogether.

Arguably, a large point of contention with halal style slaughter methods exists in the fact that these practices are performed in accordance with a religious doctrine. Due to the fact that halal style slaughter is based on Muslim doctrine, we must respect the rituals associated with this method of slaughter in order to maintain the right for individuals to practice religious freedoms in the United States. It is imperative that the balance between animal welfare and religious freedom be maintained. In response to this, those involved with the ritual slaughter of animals, whether they are legislators, meat scientists, slaughter plant workers, or religiously affiliated consumers may need to address or change aspects of current pre-slaughter and point of slaughter methods associated with halal style slaughter in order to adhere to religiously acceptable methods while maintaining animal welfare by making the end of the animals' life as painless as possible.

Ultimately, dozens of studies have been conducted in attempts to answer the question of whether or not penetrating captive bolt slaughter is more humane than halal style slaughter methods. The results from several physiological indicators such as bleed-out rates, physiological responses correlated to the ritual cut, sentience levels and brain activity in cattle slaughtered by halal methods indicate that stunning before slaughter may in fact be more humane than slaughter without stunning because it promotes a loss of sentience before slaughter, something which cannot be achieved by ritual pre-slaughter methods. In summary, alternatives or alternations to current halal style slaughter methods should be explored to improve cattle welfare while simultaneously upholding and following the Muslim doctrine surrounding the practice.

## Literature Cited

AMI. 2007. Animal handling: religious slaughter. Accessed Nov. 12, 2012.  
<http://www.animalhandling.org/ht/a/GetDocumentAction/i/7786>

Anil, M.H., T. Yesildere, H. Aksu, E. Matur, J.L. McKinstry, H.R. Weaver, O. Erdogan, S. Hughes, and C. Mason. 2006. Comparison of halal slaughter with captive bolt stunning and neck cutting in cattle: exsanguination and quality parameters. *Anim. Welfare*. 15:325-330.

CDC. 2012. U.S. Beef Industry Facts. Accessed Oct. 28 2012.  
<http://www.centerforfoodsafety.org/campaign/food-safety/mad-cow-disease/other-resources/a-consumers-guide-to-mad-cow-disease/u-s-beef-industry-facts/>

Gibson, T.J., C.B. Johnson, J.C. Murrell, C.M. Hulls, S.L. Mitchinson, K.J. Stafford, A.C. Johnstone, and D.J. Mellor. 2009a. Electroencephalographic responses of halothane-anaesthetised calves to slaughter by ventral-neck incision without prior stunning. *N. Z. Vet. Journal*. 57:77-83.

Gibson, T.J., C.B. Johnson, J.C. Murrell, J.P. Chambers, K.J. Stafford, and D.J. Mellor. 2009b. Components of electroencephalographic responses to slaughter in halothane-anaesthetised calves: Effects of cutting neck tissues compared to major vessels. *N.Z. Vet. Journal*. 57:96-101.

Grandin, T. and J.M. Regenstien. 1994. Religious slaughter and animal welfare: a discussion for meat scientists. Pages 115-123 in *Meat Focus International*. Fort Collins, CO.

Grandin, T. and P.G. Chambers. 2001. *Guidelines for Humane Handling, Transport and Slaughter of Livestock*. Food Agric. Org. of the U.S. Handbook No. 4. FAO-UN, Regional Office for Asia and the Pacific. Accessed Oct. 28, 2012.

Grandin, T. 2002. Return to sensibility problems after penetrating captive bolt stunning of cattle in commercial beef slaughter plants. *J. Am. Vet. Med. Assoc.* 221: 1258-1261.

Grandin, T. 2010. Recommended Animal Handling Guidelines and Audit Guides. Am. Meat Inst. Washington, D.C. Accessed Oct. 29 2012.

Grandin, T. 2012. Recommended Animal Handling Guidelines and Audit Guide: A Systematic Approach to Animal Welfare. Accessed Oct 28, 2012.  
<http://www.animalhandling.org/ht/a/GetDocumentAction/i/80011>

Gregory, N.G. and S.B. Wotton. 1984. Time to loss of brain responsiveness following exsanguination in calves. Resear. in Vet. Sci. 37: 141-143.

Gregory, N.G. 2004a. Religious slaughter. Page 227 in Physiology and Behaviour of Animal Suffering. Blackwell Science, Oxford, UK.

Gregory, N.G. 2004b. Recent concerns about stunning and slaughter. Meat Sci. 70: 481-491.

Gregory, N.G., F.D. Shaw, J.C. Whitford, and J.C. Patterson-Kane. 2006. Prevalence of ballooning of the severed carotid arteries at slaughter in cattle, calves and sheep. Meat Sci. 74: 655-657.

Gregory, N.G., Mv. Wenzlawowicz, R.M. Alam, H.M. Anil, T. Yesildere, and A. Silva-Fletcher. 2008. False aneurysms in carotid arteries of cattle and water buffalo during shechita and halal slaughter. Meat Sci. 79: 285-288.

Gregory, N.G., H.R. Fielding, Mv.Wenzalwowicz, and Kv.Holleben. 2009a. Time to collapse following slaughter without stunning in cattle. Meat Sci. 85: 66-69.

Gregory, N.G., Mv. Wenzalwowicz, and Kv. Holleben. 2009b. Blood in the respiratory tract during slaughter with and without stunning in cattle. Meat Sci. 82: 13-16.

Gregory, N.G., P. Schuster, L. Mirabito, R. Kolesar and T. McManus. 2012. Arrested blood flow during false aneurysm formation in the carotid arteries of cattle slaughtered with and without stunning. Meat Sci. 90: 368- 372.

HFA. 2010. Definition of halal. Accessed Oct. 28, 2012.  
<http://www.halalfoodauthority.co.uk/defintionhalal.html>.

IFANCA. 2012. What is in our food? Accessed Oct. 28, 2012.  
<http://www.ifanca.org/cms/wpages/detail/4c74f711-5ecc-4392-9d7a-22321b830f0c>

Kalweit E., F. Ellendorf , C. Daly and D. Smidt. 1989. Physiological reactions during slaughter of cattle and sheep with and without stunning. *Deutsch Tierarztl Wochenschr.* 96: 89-92.

Lambooij, E., J.T.N van der Werf, H.G.M. Reimert, and V.A. Hindle. 2012. Restraining and neck cutting or stunning and neck cutting of veal calves. *Meat Sci.* 91:22-28. *Meat Sci.*91: 22-28.

MLA. 2010. Review of stunning and halal slaughter. Accessed Oct. 28, 2012  
<http://www.mla.com.au/CustomControls/PaymentGateway/ViewFile.aspx?Viml5WCqqJYhegeKFzonMM8rohWezeGq4JSFG751mL/4PDH02luvTB5OW4ur6jL73EYMKKAfsht7d1Tnt3BqiA==>

Regenstein, J.M., M.M. Chaudry, and C.E. Regenstein. 2003. The kosher and halal food laws. *Comp. Rev. in Food Sci. and Food Safety* 2: 111-127.

USDA-FSIS. 2012. Humane handling of livestock. Accessed Oct 28, 2012.  
[http://www.fsis.usda.gov/PDF/LSIT\\_HumaneHandling.pdf](http://www.fsis.usda.gov/PDF/LSIT_HumaneHandling.pdf)