

The Politics of Religious Slaughter— How Science Can be Misused

Joe M. Regenstein

The Jewish and Muslim communities have a set of dietary laws that control the food they eat. These are part of a larger set of laws that impact almost every aspect of their daily lives. The Kosher laws for Jews and the Halal laws for Muslims have been described in some detail by Regenstein, et al. (2003). The focus of this paper is on one of the most important components of these laws, how an animal is killed for food. In both communities there has been a well-documented interest and concern for animal welfare long before it was fashionable in the Western world. Both groups traditionally use a cut at the neck to make the animal unconscious. Note also that both groups do not slaughter or use pigs.

The religious slaughter of animals is sometimes a challenge for the modern meat slaughter industry because the process is slower, it requires more skill on the part of slaughterhouse and the slaughterman, overall it requires more attention to details of animal handling, and it needs specialized equipment that is often expensive, especially for higher line speeds. But religious slaughter of animals also has some benefits in the modern era such as the fact that the animal is killed by a person with religious training who cares about the animal using a razor sharp knife that is free of nicks. This may actually be less painful than other methods if the hypothesis that endorphins are released with a calm animal at the time of slaughter so it dies on a high, similar to “runners high” is correct.

Yet, in recent years, with the rise in the interest in animal welfare, religious slaughter of animals has become a concern in many Western countries where the secular methods of slaughter are presumed to be more humane, especially when poorly done research is used to prove that hypothesis.

The current situation: New Zealand and Australia have for many years required an intervention prior to religious

slaughter for meat destined for export. In Australia, the Jewish community is permitted to slaughter, but is doing a post-slaughter intervention for cattle. In New Zealand, the local Jewish community was permitted to slaughter. After rejecting the advice of his animal welfare committee the agricultural minister banned domestic religious slaughter. It turned out that he had a financial interest in a halal slaughterhouse and worried that the Muslim export community would also ask for this right! After various legal maneuvers, the situation is that the Jewish community is permitted to slaughter as it always has, but on paper kosher slaughter of animals is prohibited. The next step in the legal process is up to the government and there appears to be no interest in moving any legal action forward. In the meantime Australia has become concerned with the slaughter of their live animals exported to Indonesia. After providing the Indonesians with slaughter boxes and stunners that do not work, they are now trying to impose a pre-slaughter intervention on the Indonesian Muslim community.

The European Union (EU) when re-doing their food labeling laws attempted to force punitive labeling on religiously slaughtered meat. The section of the law was eventually withdrawn. It is supposedly going to come up again as part of an EU discussion of animal welfare.

In Holland the lower house of parliament passes a bill banning un-stunned slaughter, unless it can be proven equal to secular slaughter although no procedure for who and how such a determination might be made was provided in the legislation. The upper house of the Dutch parliament rejected the bill because it was felt to violate religious freedom. However, discussions on how to improve religious slaughter are on-going.

In France the issue of religious slaughter of animals has been included in the 2012 presidential election politics. An end of 2011 decree would require additional requirements for religious slaughter and some restrictions on how many animals can be slaughtered religiously. In the UK, the recently adopted Red Tractor standards do not permit religious slaughter without a prior intervention. This standard has been accepted by the upcoming Olympics Board and it is not clear how the Muslim communities

Joe M. Regenstein, Ph.D.
 Professor of Food Science
 Cornell University
 Head: Cornell Kosher and Halal Food Initiative
 Stocking Hall, Cornell University, Ithaca, NY 14853-7201, USA
 JMR9@cornell.edu

will react to the absence of halal meat produced using the Prophetic Method of Slaughter.

In addition to the issue of how the slaughter is done, there seems to be a movement in Europe to reject meat over which a Muslim has said "G-d is Great", including the Church of England. This is based on the mistaken notion that "Allah" is not G-d. But Allah is simply the Arabic word for G-d. It is also interesting that in the U.S., our currency has "In G-d We Trust" and that is acceptable in a country with a stronger tradition of separation of church and state!

Why this sudden interest? Obviously, the growth and focus on animal welfare is a part of the mix. This is good and is something the religious communities need to address more seriously. Good religious slaughter as mentioned earlier requires attention to details and this is slowly being addressed by the religious communities. Pre-slaughter handling, as often emphasized by Dr. Temple Grandin is an important factor in presenting a calm animal for slaughter and this is particularly important for the religious slaughter of animals. In addition there are obviously the animal activists who have pointed out some of the failings of religious slaughter. For those cases where the problems are real, they are solvable and represent less than proper practices. Thankfully groups like the American Meat Institute, the Food Marketing Institute (supermarkets), the National Council of Chain Restaurants, and American Veterinary Medicine Association along with OIE, the international animal welfare organization, are working on slaughter standards that respectfully include religious slaughter of animals. And as consumers are in less touch with their food supply, and have no sense of slaughter, the ability to pick off one of the less understood forms of slaughter is attractive to groups whose agenda often extends beyond animal welfare to anti-Semitism, Islamophobia, and the end of animal agriculture. Also as pets and their pampering becomes the normative way for people to interact with animals, all forms of slaughter are subject to attack.

The question then is how does one evaluate the science of various methods of making an animal unconscious? And the vocabulary used in discussing these issues can have a significant impact as to how the consumer understands the issues and how the scientists frame the research.

In a subject as sensitive as religious slaughter of animals, this vocabulary can be a source of tension. Thus, calling the process "ritual" slaughter versus "religious" slaughter of animals gives it a different tone. Other members of the religious communities recommend the term "traditional" slaughter, which encompasses other traditions that cause unconsciousness by a neck/throat cut such as many on-farm slaughters, but with a much wider range of acceptable practices. But this also distracts from the idea that in the case of kosher and halal slaughter, the slaughter of animals is tied to a higher religious purpose. And the use of the term "Shechita" in the scientific literature is clearly

designed to give it a foreign, "other" context. Thus we prefer the terms traditional religious slaughter, either traditional kosher slaughter or traditional halal slaughter when writing about these processes in the scientific literature. For general purposes it might be suggested to use "The Prophetic Method of Slaughter" for halal and "The Jewish Religion's Humane Slaughter of Animals" for kosher.

And as may be clear from the text to this point, the author has mostly avoided the terms "stunned" and "unstunned", which are particularly problematic. The framing of these two words is a polarization of terms. The goal in all cases is to humanely make the animal unconscious. And the religious slaughter does so using a trained religious person, respectfully slaughtering the animal. The methods of stunning could be described as "cracking the skull", "electrocuting" the animal or "putting it into a gas chamber"! Those do not sound anywhere as nice as "respectfully hand slaughtered with respect for the animals"; so words do matter.

We actually tested wording with students before and immediately after an extensive discussion of religious slaughter. Using polling devices provides a rapid, relatively anonymous solicitation of opinions. The first question used a balance vocabulary but framing all the methods as ways to make the animal unconscious. From the following choices, which form of slaughter do you consider most humane? Use of a penetrating stunner going through the skull to cause unconsciousness, 29 votes; by using a non-penetrating stunner to crack the skull to cause unconsciousness, 12 votes; use of gases to cause unconsciousness, 42 votes; use of an electrical current to the head to cause unconsciousness, 22 votes and use of a sharp knife to cut the neck to cause unconsciousness, 47 votes. It was interesting that gassing received the highest number of votes from among the secular slaughter methods.

In the second poll taken immediately after the first poll without showing the results and with no comments, a number of students switched their votes to religious slaughter when a less balanced wording was used. From the following choices, which form of slaughter do you consider most humane? By smashing the animal over the head to crack its skull, 3 votes; by smashing through the skull, 14 votes; by electrocuting the animal, 12 votes; by using a gas chamber, 17 votes; and traditionally hand slaughtered with respect for the animal, 109 votes.

Following the lecture, which was admittedly favorable to religious slaughter and covered some of the same material that has and will be covered in this paper, the students when presented with the neutral words still voted even more strongly than before the talk for the traditional religious slaughter. From the following choices, which form of slaughter do you consider most humane? Use of a penetrating stunner going through the skull to cause unconsciousness, 10 votes; by using a non-penetrating stunner to crack the skull to cause unconsciousness, 7 votes; use of gases to cause unconsciousness, 8 votes; use of an

electrical current to the head to cause unconsciousness, 4 votes and use of a sharp knife to cut the neck to cause unconsciousness, 124 votes.

There is also the issue of clear definitions of technical terms. Tentatively: unconsciousness is when an animal generally cannot maintain posture and represents the inability to feel pain. This is the goal of the initial step of the slaughter process. The second step in the process is waiting for the animal to become insensible. When all of the head reflexes are gone, it is insensible and it is then appropriate to begin further processing the animal as an ethical requirement of both religious and secular ethics.

As always, care in defining and then using all of these words consistently would prevent some of the unnecessary confusion.

But it also needs to be recognized that some of the problems in presenting religious slaughter to the public is that the religious community is not always doing as good a job as they should be doing. For example, the handling of animals at the kosher plant in Postville, Iowa was unacceptable from an animal welfare point of view. Some of the handling of animals in Latin America for meat exports to Israel is beyond unacceptable in the modern era and reflects a lack of willingness to make the necessary investment in equipment to do a proper religious slaughter. And the problems in Indonesia and Turkey that have recently surfaced also suggest that work on halal slaughter still needs to be done if the religious community is to clearly demonstrate its commitment to animal welfare during the religious slaughter of animals.

On the other hand, consumers accept traditional on-farm slaughter and hunting, both of which have issues with how unconsciousness is obtained. When framed as obtaining unconsciousness, time is a variable but not the only one. The key issue is the quality of the death. If the animal is calmly expiring and shows no signs of stress, the time may be secondary. If the animal is struggling, then time is a major concern.

Now turning to the science of religious slaughter of animals: The first consideration is how was the religious slaughter done? There are clearly many methods, e.g., upright restraint (various systems), upside down restraint (various systems), shackling and hoisting with or without subsequent movement and casting, and various forms of traditional casting. The state of the animal at the start of such slaughters will vary greatly, yet if one looks at the literature, this information is rarely provided, much less the actual details. In two cases where the author has asked about the slaughter, the well known animal welfare scientist presenting their OWN data has said "I do not know." Is that not a violation of the "Religion of Science"? There are clearly bad slaughter systems and one has to suspect that some researchers have chosen a bad religious slaughter system to compare with a good secular system! Some of those doing the work from the religious point of view

may have done just the opposite – so it is often very hard to generalize the work in the scientific literature.

And the summaries of "time to death" for religious slaughter are often reported as the maximum time for one animal to become unconscious, rather than the means and range and other relevant statistical information! Please note that this author strongly supports establishing a specific time where an animal is not unconscious from the religious slaughter will have a post-slaughter intervention that puts the animal down even if this means the loss of acceptability of that animal as religiously slaughtered.

Besides the broad issue of how the slaughter was done, there are still a number of details of the actual slaughter that needs to be considered and reported in the literature, whether it be observations in the field of actual religious slaughter and even more importantly if the work is being done in a laboratory setting. Often in the latter case, the term "unstunned" slaughter is used, which is fine. But if the discussion is then focused on religious slaughter of animals, one has to ask if the "unstunned" system is relevant to the religious slaughter. The most recent series of papers by Gibson et al. (2009a,b,c,d) is a clear example of this lack of congruence! The use of a 10 inch machine sharpened knife is totally irrelevant to the use of a razor-sharp nick-free 14 inch chafel!

On the other hand, the animal welfare of religious slaughter needs to be improved consistent with and respectful of all religious rules. The religious community needs to take on this responsibility with help from the scientific community. The scientists, hopefully, have as their goal working with the religious community to figure out how to do things better rather than having a "gotcha" attitude. Unless the best religious slaughter systems available are studied when they are working properly, the science points out any problems with the system being studied but cannot be used to criticize religious slaughter as such. These studies do help to identify specific areas where improvements need to be made to THAT system.

Moving forward, there must be standardized methods and terminology for evaluating and reporting all types of slaughter methods. Ironically this has not been done! Most papers do not provide enough information to even come close to duplicating the slaughter, unless one works in the same plant, one has no idea what really happened.

How does one evaluate a slaughter system? Time to collapse is one concept. A good system needs to get the animal both unconscious and insensible without stress, ideally in the minimal amount of time. (A consensus on the time is needed, i.e., this is really a policy issue and not a scientific issue.) An appropriate maximum acceptable time for cattle for visible unconsciousness, i.e., collapse of the animal might be 45 seconds. In a good system Temple Grandin has observed that the average for cattle is 17 sec and the longest time for a good slaughter was 33 sec. Behavioral observations should also suggest that the

animal during this period is not struggling! Any animal that is not collapsed after that agreed upon time or if it is visibly stressed even if the animal becomes unacceptable for kosher or halal needs an intervention that will cause immediate unconsciousness. At least one “Temple Grandin approved plant” is using this standard and routinely getting over 95% of the cattle to collapse in about 30 sec. But one should still ask: Can they do better? Has anyone done any scientific studies in these model plants to collect key baseline data as to where we are with the best religious slaughter to use for setting goals for other plants?

The impact of the actual religious slaughter needs to be separated from a number of extremely important issues that are not “religious requirements” but which confound the research results, e.g., the people, the facility, the equipment, and the non-slaughter stress of the animals need to be optimized before looking at the impact of the religious slaughter procedure. The author would suggest that the literature studies do not meet the standard of sufficient information so that the experiment can be repeated or the data cleanly interpreted, which is surprising for such important questions that have taken up so much research effort and expense.

The recent papers by Gibson et al. (2009a,b,c,d) are an example of such a questionable piece of work. These papers have many serious limitations. A list of some of those concerns will be presented. Dr. Grandin has put a disclaimer on her web site criticizing this work. Yet these papers are being used politically in Europe as the “proof” that religious slaughter is inhumane!

The knife used was rather short—only 10 inches and the actual slaughter and the “pen” are poorly described. The special equipment used to restrain the animals is not shown. What about details about the actual cut – how many strokes and where on the neck? The head holder may also permit too much movement? The training of the slaughterman is not given. Like so many papers, they do not give enough details to evaluate the religious slaughter (or un-stunned slaughter as they call it). Only in the discussion is religious slaughter discussed without establishing whether the work itself is actually relevant.

The sham cut is actually more like a negative control, i.e., what happens with minimal pressure. No information is provided on the impact of a lot of pressure with no cutting on some of the parameters measured. And who sharpens a knife with a knife sharpener?

Why is the heart rate so high for the first paper and much lower in two of the other papers? It suggests that some animals were more stressed? This is often observed for the convulsions after slaughter regardless of method. It also seems that the normal “sticking” of the animal after non-penetrating stunning was never done and would be another important control.

They actually admit in one of the papers that the halothane treatment might have had an effect on some of the results!

The papers are sloppy about how the words unconsciousness, insensibility, and undoubted insensibility are used. And the papers also seem to reference a lot of the bad religious slaughter for the times they quote for time to insensibility, and is it insensibility or unconsciousness? Isn't the later more critical? Words like suffering and psychological shock are used without definition or justification. **And a lot of “wishy-washy” words, like “probably, likely, possibly”** are used in the papers, yet the authors are publicly supporting a strong anti-religious slaughter position.

The issue of occlusions that block proper bleed out and the issue of blood in the lungs are issues that need to be better understood. For example, even when occlusions occurred according to these authors, they seemed to have had no effect. Dr. Grandin suggests with respect to blood in the lungs that what is needed is the correlation of aspiration into the trachea and the time to drop. Recent work suggests that this effect can be minimized by a cut higher up the neck, which remains to be confirmed.

The papers talk about possible errors in their use of the non-penetrating stunner: they had a 28% failure rate for the stunner?

Neck tension: The exact tension on the neck is critical to get a cut that is clean—if it is not taut enough the cut is sloppy and if it is too taut one may get tearing ahead of the cut. Thus, this needs to be clearly specified in terms of the head position as per Dr. Grandin's work with head holders although her recent work suggests a slightly less taut neck may be better. Can we develop a method to measure this?

According to the American Meat Institute (AMI) standards, cattle vocalization percentages should be 3% or less of the cattle in the crowd pen, lead up chute and restraint device. A slightly higher vocalization percentage (5% vs 3%) is acceptable for religious slaughter because the animal must be held longer in the restraint device compared to conventional slaughter. A 5% or less vocalization score can be reasonably achieved (has this been reported for any of the religious slaughter systems studied?).... Animals must be completely insensible before any other slaughter procedure is performed_(e.g., shackling, hoisting, cutting, etc.) If the animal does not become insensible, it should be stunned with a captive bolt gun or other apparatus_and designated as non-Kosher [non-Glatt] or non-Halal if required by the religious authorities. (Please note that vocalization does not work with sheep.)

Clearly there is a great deal of research that needs to be done. An outline of a possible agenda for starting the discussion of what research might be needed is presented in Appendix 1. The author would be happy to receive professional comments on that document.

A key hypothesis that needs further testing is that of whether the “endorphins” (opiates) release occurs in animals at the time of slaughter. The role of the SHARP cut in optimizing endorphin release needs to be determined. Another need is for a way to measure the sharpness of

a knife quantitatively and to determine the absence of nicks. Detailed animal physiology, biochemical, and behavior measurements on a good system where during religious slaughter animals are losing the ability to support themselves in preferably 20 sec or less could provide a better understanding of what is needed for good religious slaughter.

CONCLUSION

It is my personal belief that in the future good science will show that the most humane slaughter *may* well be religious slaughter. All research on the issue of religious slaughter (as opposed to evaluating a particular situation) needs to be done on a system that is operating properly and provides the best possible condition for slaughter – only then can the potential and limitations of religious slaughter be properly evaluated by both the religious community and the scientific community. My dream is that some day all animals will be slaughtered religiously as the best form of slaughter. Imagine if even pigs get slaughtered that way by non-Jews, non-Muslims who have the same high level of slaughter training?

SUPPLEMENTAL INFORMATION

There is a comprehensive paper at www.ift.org on the full range of kosher and halal rules; please go to publications: Comprehensive Reviews, volume 2 issue 3. For on-line talks on kosher/halal and on animal welfare (by JMR) and animal welfare (by Temple Grandin), please go to www.cybertower.cornell.edu. For a 2 credit distance learning course on kosher/halal go to the Kansas State University distance learning program in food science.

APPENDIX 1

Outline of Issues for a Critical Review of Religious Slaughter for Mammals

This is a list of the issues that need to be addressed both by the scientific/research community and by management and/or by the community beyond the slaughter house, including both religious and secular authorities.

Some of the issues may not involve current scientific issues, but even if not a topic of research, they are included so that 1.) If the information is wrong or needs up-dating it can be addressed, and 2.) If changes in procedures are needed, it is important to have the bigger picture in mind to hopefully minimize unintended consequences elsewhere of any proposed changes.

Animal Specific Information

I would be helpful to have a good set of anatomical drawings showing the various blood vessels between the heart and the brain for the key animals being discussed and compared, i.e., cattle, sheep, and camel. Drawings of

where on the neck the kosher or halal cut can be made also need to be made available, including the anatomy within the neck in that area.

Long Before Slaughter

Minimize stress: How does one minimize stress on the farm, and during transportation and lairage at the slaughterhouse? How does one select animals that are appropriate for religious slaughter, i.e., more used to seeing humans?

Animal health: How can the rejection of animals for lung adhesions or other religious defects during kosher slaughter be minimized? Can studying this in live animals (e.g., ultrasound) improve animal health generally? Can pre-slaughter random inspections on the farm eliminate problematic animals or herds?

Just Prior to Slaughter

Lairage: When does one remove feed and water? How does one physically design an optimal system from lairage to slaughter, e.g., flooring, lighting, noise and glare? How does one minimize vocalization and electric prod use? Can vibrators replace the electric prod?

Washing and/or Shearing: Should animals be prepared ahead of time for religious slaughter?

At the Time of Slaughter

Level of stress: Can one determine if a little stress just before slaughter is good for loss of consciousness, i.e., to get the heart rate up and lose blood faster? Can rapid tests using glucose and lactic acid be used to measure stress during slaughter?

Religious personnel

Site for killing: Exactly where on the neck should the kill be done? How does one measure the site of cutting afterwards?

Speed of kill: Is a more aggressive and/or fewer strokes better? How can this be monitored? (Possibly a role for video auditing?) Does this impact on the number of aneurisms?

Angle of the knife: Does the angle of the knife during the cut make a difference, i.e., cutting straight across, slightly up or slightly down? How can this be monitored?

Alternate method of killing: The Muslim community uses a unique chest stab method for camels (called "Nahr") that could in principle be applied to other animals, especially cattle. Is this method accepted by the Muslim community for other animals? What are the pluses and minuses of this method?

Immediate Checking: After slaughter when the Jewish slaughterman checks that the cuts were made properly are there any special instructions needed to minimize contact with the cut skin surfaces? Should Muslim slaughtermen

be encouraged to do the same? Can this procedure help with decreasing annurisms?

Second cut: Under what circumstances and by whom and how might a second cut be made after the religious slaughterman if the slaughterman considers the cut insufficient? Are there different rules for kosher and halal?

Should other methods be used to put down an animal that is remaining conscious longer than a specified time? If so, what is the best way to do this from an animal welfare and worker safety point of view?

Equipment: Video Auditing: How does this important technique get instituted as a management tool to assure that animals are slaughtered properly?

Equipment: The restrainer: How should they be properly designed? *Upside down pen*: needs to turn quickly and have proper support of the animal once upside down and while turning. When should the headholder be released and when should the animal be turned back upright? How does one determine the time to unconsciousness while the animal is in the box? *SPCA Box*: Can the belly holder be better designed? Would designing an upright pen with a double rail that actually supports the animal off the ground be beneficial? *Low volume upright pens*: How can they be optimized for animal welfare while retaining the lowest possible price, including restrainers for large steers and bulls? How can greater use of these pens be encouraged? *V restrainer*: Can the ergonomics of the cutting be improved for the slaughterman? *High Speed Moving Double Rail*: Can these be built at a lower cost so more plants could afford them? *General*: Can the equipment be redesigned so that the animal can be moved away from the equipment but given time to become unconscious and eventually insensitive without violating animal welfare considerations? How does one deal in a systematic way with any animals that are not unconscious coming out of a restraining device?

Equipment: The head holder: How does one measure neck tension and head movement? How does one measure the proper angle that is needed?

Equipment: The knife: *Length*: How does one establish the ideal length and shape? Is twice the neck width and perfectly straight blade the correct requirement? *Sharpness*: How does one measure the sharpness of the blade? *Nicks*: How does one measure this objectively? Can Muslim slaughtermen be taught to do this regularly?

Immediately After Slaughter

Time to Unconsciousness: How does one measure it? How does one use it as a management tool? How does one evaluate the quality of the transition to unconsciousness rather than just the time to unconsciousness?

Blood pressure to unconsciousness: At what blood pressure does an animal become "unconscious"? Is this blood pressure different in different parts of the brain? Does it vary between species and from animal to animal?

Quality of the kill: How does one evaluate these mainly behavioral traits?

After Insensibility

Measuring occlusions: How might this be done routinely as a management tool?

Lung auditing: How does one measure where the blood is in the lung? How does one measure the cut after the fact, i.e., what percent of each vein/artery cut and where? How does one minimize the number of occlusions?

Endorphin Hypothesis: Can one determine whether the endorphin hypothesis as a way for an animal to die on a high has any merit?

Time to Insensitivity: How do we check for the loss of the corneal reflex (i.e., the blinking reflex) and is this measurement the correct measurement to make? Can this or another measurement be mechanized and monitored automatically on every animal.

Time to Hanging: How does one assure that the animal is unconscious (or must it be insensible) before being hung?

Time to Cutting: How do we assure that the animal is insensible (i.e., is this essentially brain death) before further cutting?

Beyond the Slaughterhouse

What should be the requirements for the training of slaughtermen in terms of animal welfare? Should some licensing scheme be developed? What type of monitoring of slaughtermen is appropriate? Should slaughterhouses be required to have a written kosher and/or halal protocol that both the secular and religious supervising body can inspect and evaluate?

Overall

Good versus bad plants: What are the standards that one wishes to see achieved? How does one get all religious slaughterhouses up to a minimal animal welfare standard? How does one make the good plants even better?

(Note: It might be the case that kosher slaughter is the optimum method of slaughter of kosher species but not necessarily for non-kosher species, some of which have a more developed collateral cerebral circulation than cattle.)

The above outline is based on a number of articles and discussions with a number of colleagues. (Khalid, 2011) has an extensive literature review that is a good starting point for a comprehensive literature review that is needed. The preliminary report prepared for use in Holland (Regenstein, 2011) documents in more detail some of the problems with the current literature. Dr. Grandin's website (www.grandin.com) contains a great deal of material on religious slaughter including a few papers and the disclaimer for the work in New Zealand. Stuart Rosen's (2004) critical review that was peer reviewed but was

not permitted to be published as such by the Veterinary Record is an important paper. Rabbi/Dr. Levinger (Levinger, 1995; Munk et al., 1976) has written two books that provide a comprehensive review of the physiology of religious slaughter, mainly kosher, although it does not general separate the impact of the different forms of religious slaughter.

KEY REFERENCES

(Not all of which have been cited in this paper)

- Gibson, T. J.; Johnson, C. B.; Murrell, J. C.; Chambers, J. P.; Stafford, K. J.; Mellor, D. J. (2009a): Components of electroencephalographic responses to slaughter in halothane-anaesthetised calves: Effects of cutting neck tissues compared with major blood vessels. *New Zealand Veterinary Journal* 57, 84-89.
- Gibson, T. J.; Johnson, C. B.; Murrell, J. C.; Hulls, C. M.; Mitchinson, S. L.; Stafford, K. J.; Johnstone, A. C.; Mellor, D. J. (2009b): Electroencephalographic responses of halothane-anaesthetised calves to slaughter by ventral-neck incision without prior stunning. *New Zealand Veterinary Journal* 57, 77-83.
- Gibson, T. J.; Johnson, C. B.; Murrell, J. C.; Mitchinson, S. L.; Stafford, K. J.; Mellor, D. J. (2009c): Amelioration of electroencephalographic responses to slaughter by non-penetrative captive-bolt stunning after ventral-neck incision in halothane-anaesthetised calves. *New Zealand Veterinary Journal* 57, 96-101.
- Gibson, T. J.; Johnson, C. B.; Murrell, J. C.; Mitchinson, S. L.; Stafford, K. J.; Mellor, D. J. (2009d): Electroencephalographic responses to concussive non-penetrative captive-bolt stunning in halothane anaesthetized calves. *New Zealand Veterinary Journal* 57, 90-95.
- Grandin T. (1994): Euthanasia and slaughter of livestock. *Journal of the American Veterinary Medicine Association* 204:757-759.
- Grandin, T. (2010): Recommended Animal Handling Guidelines and Audit Guide, June 2010 Edition. American Meat Institute, Washington, DC.
- Grandin, T. (2011): www.grandin.com. Recommended Ritual Slaughter Practices.
- Grandin, T.; Regenstein, J. M. (1994): Religious slaughter and animal welfare: a discussion for meat scientists. *Meat Focus International*, 115-123.
- Jacoby, L.; Moses, J. (2011): www.spiritofhumane.com . Spirit of Humane.
- Khalid, R. (2011): The Bleeding of Slaughtered Lambs for the Purposes of Halal Slaughter. Part 2: Literature Review. M.Sc. Thesis: University of Bristol.
- Kijlstra, A.; Lambooij, E. (2008): Report 161. Ritual Slaughter and Animal Welfare. Animal Sciences Group at Wageningen UR.
- Lambooij, E.; van der Werf, J.T.N.; Reimert, H.G.M.; Hindle, V.A. (2010): Report 398. Report on restraining and neck cutting or stunning and neck cutting in pink veal calves. Animal Science Group at Wageningen UR.
- Levinger, I.M. (1995): Shechita in the Light of the Year 2000: Critical Review of the Scientific Aspects of the Methods of Slaughter and Shechita. Maskil L'David, Jerusalem.
- Munk, M.L. Munk, E.; Levinger, I.M. (1976): Shechita: Religious and Historical Research on the Jewish Method of Slaughter. Gur Aryeh, Institute for Advanced Jewish Scholarship, Brooklyn.
- Regenstein, J. M. (2000): Humane (Halal) on-farm slaughter of sheep and goats.
- www.sheepgoatmarketing.info/news/HumaneSlaughter.pdf , Northeast Sheep and Goat Marketing Program, Mike Thonney, Department of Animal Science, 114 Morrison Hall, Cornell University / Ithaca, NY 14853-4801, 607.255.2851 / mlt2@cornell.edu,
- Regenstein, J.M. 2011. Expert Opinion on Considerations When Evaluating All Types of Slaughter: Mechanical, Electrical, Gas and Religious Slaughter and A Critical Scientific Review of Report 161: Ritual Slaughter and Animal Welfare (September, 2008); Report 398: Report on Restraining and Neck Cutting or Stunning and Neck Cutting in Pink Veal Calves (September, 2010) by the Animal Sciences Group, Wageningen UR; and the 2009 New Zealand Papers by Gibson *et al.* Preliminary Report. Prepared for the Netherlands Parliamentary Debate on Religious Slaughter. Issued by the Netherlands Jewish Community. 49 pages.
- Regenstein, J.M.; Chaudry, M.M.; Regenstein, C.E. (2003): The kosher and halal food laws. *Comprehensive Reviews in Food Science and Food Safety* 2, 111-127.
- Rosen, S.D. (2004): Physiological insights into shechita. *Veterinary Record* 154, 759-765.
- Zivotofsky, A.Z.; Strous, R.D. (2012): A perspective on the electrical stunning of animals: Are there lessons to be learned from human electro-convulsive therapy (ECT)? *Meat Science* 90:4, 956-961.