Humane Slaughter: Broiler Chickens

Introduction

Slaughter practices in our global food supply chains have gained significant attention recently, both from within companies and from the media and consumers. This document provides information on the humane slaughter of broiler chickens, including an overview of the main methods of slaughter in use commercially and recommendations for corporate animal welfare policies. Suitable outcome measures for assessing welfare at slaughter are suggested and their use in continuous welfare improvement programmes discussed.

Main methods of slaughter used for broiler chickens

1. **Electrical**
   Electrical waterbath stunning is the main method used globally for the slaughter of poultry. There are however, significant animal welfare concerns with this method and in 2012 the European Food Safety Authority recommended against its use[1].

   a. **Electrical waterbath stunning:** The birds' legs are inserted into a metal shackle which holds the birds upside down on a moving line and their heads pass through an electrified waterbath. Electricity flows through the body and up the metal shackle. In principle, electrical methods of slaughter for broiler chickens can be humane, however, there are serious welfare concerns with electrical waterbath systems:
      - A major concern comes from the electrical parameters used. The electrical parameters that result in an effective stun (low frequency, high current) can also cause blood spots in the muscle, bruising and broken bones, all of which reduce the value of the carcase. These meat quality issues are a result of the electrical current causing strong and simultaneous muscle contraction. For this reason, higher frequencies and lower currents are typically used, resulting in fewer meat quality issues but a greater number of birds being ineffectively stunned. There is a trade-off between bird welfare and meat quality[2].
      - A similar trade-off exists when electrical waterbath systems are used for slaughter according to religious requirements. In these instances, there is a requirement for recoverable stunning and higher frequencies are used to reduce the likelihood of causing cardiac arrest, despite lower frequencies resulting in more effective stunning. The electrical waterbath is designed as a *stun-kill* method (albeit an unreliable one) and attempting to use it for *stun-only* reduces its effectiveness further.
      - There are issues with the consistency of the parameters each bird receives, as there are several birds in the waterbath stunner at any one time and individual birds will have different levels of electrical resistance[2]. If the electrical parameters delivered to each bird are not sufficient, there is a risk birds will recover consciousness during bleeding, or that birds are electro-immobilised (the birds are paralysed but still conscious). In 2012, EFSA conducted a study of various electrical parameters used in electrical waterbath systems and could not identify any parameter combinations that resulted in 100% of birds being effectively stunned[1].
      - The shackling and inversion of the birds required for electrical waterbath stunning (and the handling of the birds by operators that this entails) causes the birds pain and stress[3] and is another major disadvantage inherent to the method. Low or blue lighting helps to keep the birds calm during shackling and is recommended in all live handling areas. Breast supports can be incorporated into some electrical waterbath systems – these can either consist of a flat panel that comforts the birds and reduces wing flapping, or a moving conveyor belt that partially supports the weight of the bird and reduces pressure on the legs from the shackles[4].

It is difficult to provide general recommendations on the best electrical parameters to use in electrical waterbath systems as so much depends on the individual set up of the waterbath, the birds being slaughtered, etc. Neither is it possible to specify one effective minimum current for all the electrical waveforms and frequencies used under commercial poultry processing conditions. For this reason, the EU Slaughter Regulation[5] gives minimum currents for a range of electrical frequencies for poultry and, as a consequence, the level of animal welfare cannot be guaranteed. For electrical waterbath stunning of broilers, the Humane Slaughter Association recommends[6]:

Frequency (Sine AC)	Current (RMS)	Application time
< 200 Hz	100 mA	10 seconds
200 to 400 Hz	150 mA	10 seconds
400 Hz	200 mA	10 seconds

Electrical waterbath stunning should always be followed as soon as possible by bleeding, within a maximum of 15 seconds from the birds entering the waterbath. For further information, see Compassion's document on Improving Electrical Waterbath Stunning[4].

b. **Head-only electrical stunning:** Electrical stunning systems that provide individual head-only stunning of birds, with more precise control of the electrical parameters each bird receives are under development. Examples of these have been developed and trialled in the Netherlands by Topkip[7] and Dutch Vision Solutions[8]. The Topkip head-only equipment also incorporates a system for restraining the birds in plastic cones; the birds' legs are still placed in metal shackles but the cones support the weight of the bird which keeps the birds calmer and lessens the pressure on the legs[7].

2. Controlled Atmosphere

Controlled atmosphere (gas) systems are increasing in use and account for the majority of poultry slaughter in the UK. Advantages include consistency in application across all birds in the system and, since these are *stun-kill* systems, there is no risk of the birds recovering consciousness during bleeding. Another significant advantage is that the birds can remain in the transport modules throughout the process, avoiding the need for additional live handling.

a. **Carbon dioxide:** Carbon dioxide is aversive in low concentrations, and highly aversive in high concentrations. Aversiveness to carbon dioxide increases in severity when the carbon dioxide level is 30% by volume or more whereas concentrations below 30% carbon dioxide have limited evidence of pain and aversiveness[9]. High concentrations, over 70%, kill birds quickly as carbon dioxide acts directly on the nervous system to stop breathing in addition to blocking availability of oxygen. Carbon dioxide is used in the majority of controlled atmosphere systems and is used in two main ways: multi-phase systems involve successive exposure to a gas mixture containing up to 40% carbon dioxide to stun the birds, followed by exposure to a higher concentrations of carbon dioxide (>55%) which will kill; the alternative method is to use combinations of carbon dioxide (up to 30%) and other gases – inert gases and sometimes oxygen – which lessens the aversiveness of the gas to the birds[9]. Single-phase carbon-dioxide systems also exist (where birds are introduced to a static concentration of gas) but are not recommended as birds in these systems demonstrate more agitation and more severe convulsions (thereby increasing the potential for injury)[10,11].

b. **Inert gases:** These include argon and nitrogen. As the name suggests, these are non-toxic and non-aversive to the birds. The birds die through a lack of oxygen. To be reliable, the gas has to be maintained with a maximum of 2% oxygen and the method takes longer to kill than carbon

dioxide systems. However, as the gases are not aversive this is considered less stressful than carbon dioxide methods[12]. Despite being considered better for welfare, inert gas systems are used less commonly than carbon dioxide systems as the gases are more expensive and because the method results in a period of vigorous wing flapping after the birds lose consciousness, which can lead to increased rates of carcase damage.

c. **Low Atmosphere Pressure Stunning (LAPS):** This method is still in its infancy and is currently being used commercially in one large-scale processing plant in the USA. The method works by gradually removing air (and therefore also oxygen) from a chamber containing the birds. Research indicates that this method is an effective *stun-kill* method with fewer signs of aversion than controlled atmosphere methods using carbon dioxide, equivalent to inert gas systems[13]. The method has been developed by Technocatch[14] and efforts to seek approval for use of the method within the EU are underway[15].

3. Percussive

a. **Captive-bolt stunning:** Penetrative and non-penetrative captive-bolt stunning equipment is generally only used for emergency or back-up stunning of broiler chickens. In slaughterhouses, back-up stunning equipment should be at hand for operatives at the point of slaughter and in the lairage. Captive-bolt stunning must be followed as soon as possible by bleeding, or neck dislocation in the case of emergency killing.

Bleeding
Bleeding is used to kill broiler chickens after application of pre-slaughter stunning (*stun-only* methods) and forms part of the preparation for further processing for all methods of slaughter (i.e. including after *stun-kill* methods of slaughter). The process may be performed by hand or by automatic neck cutters (a rotating blade). The most humane methods of bleeding are those which cause a rapid loss of blood so that death is brought about as quickly as possible. In the case of broiler chickens, the recommended method of bleeding is a ventral neck cut made with a clean, sharp blade as soon as possible after stunning (this must be within 15 seconds maximum) to ensure death occurs before consciousness can be regained. Neck cutting must sever both of the carotid arteries or the vessels from which they arise. The birds must be suspended and allowed to bleed for a minimum of 90 seconds before further carcase processing can begin.

Neck Dislocation
Neck dislocation of broiler chickens kills by rupturing the spinal cord (stopping breathing) and by rupturing blood vessels in the neck (disrupting blood flow to the brain). It is performed manually or using mechanical apparatus. However, research indicates that neck dislocation may not cause immediate unconsciousness[16]. For this reason, neck dislocation must only be used as a back-up or emergency method of killing broiler chickens, when no other better method is available, and should not be used as a routine method – this is also stipulated in EU legislation[5]. For emergency killing in a disease situation, it may be preferable to use neck dislocation, instead of bleeding, as a killing method after application of a stunning method to minimise disease risk from spillage of blood and other bodily fluids.

Recommendations for corporate policies on humane slaughter of broiler chickens

1. All animals killed for meat should be slaughtered humanely. For broiler chickens, the use of *stun-kill* controlled atmosphere methods using inert gases are recommended above other methods where possible. The use of electrical waterbath systems for broiler chickens should be phased out.

2. The killing of animals by bleeding without the use of pre-slaughter stunning is not considered a humane method of slaughter. Corporate animal welfare policies should stipulate that all meat in the supply chain comes from animals that have been subject to pre-slaughter stunning.

3. All systems for killing animals should be effectively managed and monitored. This includes:
   - The development and use of Standard Operating Procedures (SOPs) for all live animal operations
   - Effective training of all staff involved in live animal operations
   - Designating a member of staff responsible for animal welfare in the slaughterhouse, an "Animal Welfare Officer", whose role it is to monitor operations to ensure SOPs are followed and to require remedial action be taken if non-compliance or other issues are found
   - Use of CCTV in all live animal handling areas, with effective monitoring of the footage
   - Effective measurement and proactive management of welfare outcomes at slaughter
4. With controlled atmosphere systems:
   - A *stun-kill* method should be used to remove the risk of the animal recovering consciousness.
   - Inert gases are preferred over carbon dioxide as they are less aversive and cause the birds less stress.
   - If carbon dioxide systems are used, a multi-phase system is recommended whereby the birds are initially subjected to concentrations up to a maximum of 40% carbon dioxide to stun the birds and thereafter subjected to higher concentrations to kill.
   - Controlled atmosphere systems should be designed so that the birds can remain in the transport modules, without the need for any additional live handling at the slaughterhouse.
5. With electrical waterbath systems:
   - Compromises to the welfare of the birds should not be made for the sake of meat quality. Electrical parameters should be chosen that result in an effective stun which lasts until death is caused by bleeding and that minimise the risk of electro-immobilisation (birds being paralysed but still conscious).
   - Bleeding must be performed as soon as possible following stunning to reduce the risk of recovery before death occurs – within a maximum of 15 seconds from the start of stunning.
   - The throughput should be at a rate that minimises the number of birds that miss automatic neck cutters and that allows operatives to adequately check each bird for signs of unconsciousness. Similarly, there should be enough operatives at hanging-on to ensure that the process is not rushed and that birds are handled calmly.
   - For further details on electrical waterbath systems, when their use cannot be avoided, see Compassion's document on "Improving Electrical Waterbath Stunning"[4].

Welfare outcomes at slaughter

In order to proactively monitor and improve animal welfare at slaughter it is necessary to start by identifying appropriate measures of welfare. Whilst it is important (and in many cases mandatory) to record non-animal-based measures, such as electrical stunning parameter data, it is also important to look at the animal. Welfare outcome measures are animal based measures which reflect the key issues concerning the welfare of the animals. They are influenced by several factors and corrective action may require investigating a range of potential solutions.

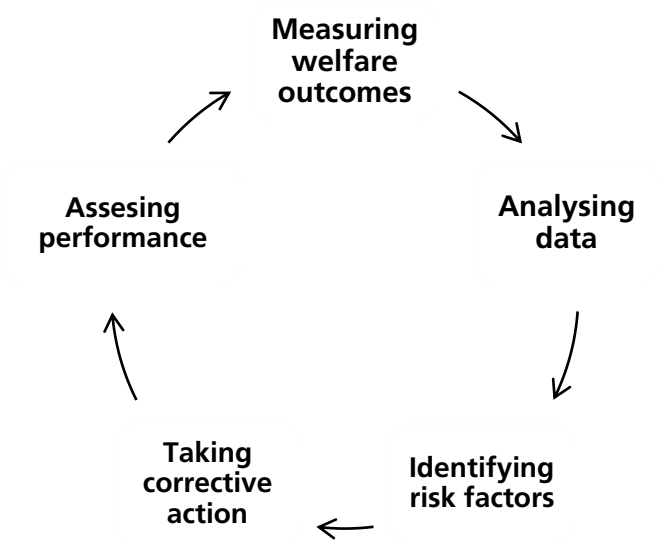
Corporate policies on animal welfare should stipulate that welfare outcome measures are used at slaughter. Recommended welfare outcome measures for broiler chickens in slaughterhouses include:

Welfare Outcome	Detail
Behaviour at unloading	**WHAT:** A qualitative assessment of the behaviour of animals at unloading. **WHY:** The behaviour of the birds at unloading is an indicator of the transport and farm conditions. Poor transport conditions (influenced by the vehicle environment, drive quality, weather conditions, etc.) or poor stockmanship on the farm will result in more birds being deemed cautious or flighty. **HOW:** A qualitative assessment of the flock during and immediately after the process of unloading the birds from the lorry into the lairage. Their behaviour may be categorised into *calm*, *cautious*, or *flighty*. **TARGET:** 100% of the birds to be calm.

Dead on arrivals (DOAs)	**WHAT:** Birds arriving dead at the slaughterhouse. **WHY:** This is an indicator of poor transport conditions (influenced by the vehicle environment, drive quality, weather conditions, etc.). **HOW:** This measure should be continuously recorded. Record the number and percentage of birds dead on arrival at the lairage. **TARGET:** 0% birds dead on arrival.
Injuries in the lairage	**WHAT:** Incidences of birds being injured in the lairage. **WHY:** Birds can be injured by moving equipment, poor condition transport crates, other birds and poor handling. **HOW:** This measure should be continuously recorded. Record the number of birds suffering injury and the percentage of birds this represents, plus the type of injury and any subsequent action taken. **TARGET:** 0% birds injured in the lairage.
Indicators of consciousness	**WHAT:** An assessment of consciousness performed during the time interval between stunning and death. **WHY:** For slaughter to be considered humane, birds must be effectively stunned (rendered unconscious) so that they do not experience pain or stress during the process. **HOW:** This measure should be continuously recorded. Assess indicators of consciousness during bleeding (see later table for a full list of potential indicators that can be used) and record the number and percentage of animals that show signs of recovering consciousness. Also record the action taken when birds showing signs of consciousness are detected. **TARGET:** No birds to show signs of returning to consciousness. *If signs of consciousness are seen, birds must be immediately re-stunned or stunned with an alternative, back-up method.*
Pre-stun shocks	**WHAT:** Birds may receive electric shocks on entry to an electrical waterbath stunner which are not sufficient to cause unconsciousness but which cause pain. These can be caused, for example, when a birds wings make contact with a wet entry-ramp before the bird's head has entered the waterbath. **WHY:** The birds are still conscious and therefore these pre-stun shocks cause pain. Pre-stun shocks indicate that the waterbath is poorly designed and/or operated. **HOW:** The incidence of pre-stun shocks can be recorded from a sample of birds observed entering the waterbath. **TARGET:** No birds to receive pre-stun shocks.
"Red Skins"	**WHAT:** "Red Skins" are birds that have entered the scalding tank having failed to be stunned by the electrical waterbath and having also missed the neck cutter[17]. **WHY:** These birds therefore die by drowning, whilst still conscious. This cannot be considered a humane death. **HOW:** This measure should be continuously recorded. Record the incidence of "Red Skins" and the percentage birds this represents. **TARGET:** 0% birds.
Post-mortem lesions	**WHAT:** Lesions found on and inside the carcases during further processing. **WHY:** Post-mortem lesions, such as bruises and broken bones, can represent painful injury that may have been caused during the live handling

	procedures or the stunning and slaughter methods used in the slaughterhouse. **HOW:** Record post-mortem lesions found from a sample of carcases, e.g. bruising, broken bones and blood spots within the meat.
Emergency animal procedures	**WHAT:** Birds that are required to be emergency killed in the lairage. **WHY:** Rates of emergency killing of birds in the lairage reflect conditions during lairage. Transport and on-farm. Reasons for emergency killing may include heat stress, disease and serious injury. **HOW:** This measure should be continuously recorded. Record the number and percentage of animals that are emergency killed in the lairage, the reason why this was required and the action taken.

Welfare outcome measures should be used as part of a proactive programme of measurement and continuous improvement target setting. A programme should involve a continuous cycle of:



Regular monitoring of welfare outcomes enables swift detection of problems, implementation of corrective action and continuous improvement to be achieved. Some measures should be continuously recorded (as indicated in the table above). For the other measures, it is recommended that they are recorded on a representative sample of a minimum of 100 animals per flock[18]. Target setting should be used for all measures, to drive improvement.

Indicators of consciousness

If any of the following signs of an effective stun are not seen then it may indicate that the bird is returning to consciousness. If in any doubt as to whether a bird is unconscious, do not hesitate to repeat the stun or use an alternative, back-up method.

Signs of an effective stun	Comment	Stunning methods applicable to
Completely destroyed skull and brain	Bleeding through the wound.	Mechanical
Immediate collapse	This may not be visible when poultry are restrained in a cone or shackle.	Mechanical, Electrical

Immediate onset of tonic seizure (arched neck, tetanus, rigid legs, can include wing flapping and body tremors)	Lasting several seconds. During the period of seizures, the eyes are wide open (no blinking when touched).	Mechanical, Electrical
Clonic seizures (leg kicking and wing movement - not wing flapping)	Clonic seizures are mild.	Electrical
Absence of rhythmic breathing	Lasting throughout clonic-tonic periods. Monitored by regular flank movements or by condensation on a cold mirror placed in front of the mouth and nostrils.	Mechanical, Electrical, Controlled Atmosphere Stunning
Hypoxia-induced convulsions (wing flapping)	In Controlled Atmosphere Systems, if the hypoxia has been induced gradually, the birds are unconscious during the occurrence of wing flapping. The onset of convulsions themselves can be used as an indicator of loss of consciousness.	Controlled Atmosphere Stunning
Loss of corneal reflex (blinking in response to touching the cornea of the open eye)	Corneal reflex is one of the simplest indicators of consciousness for use on broiler chickens: the absence of a blink reflex when the cornea (the surface of the eyeball) is touched indicates that the animal is unconscious. Presence of a blink reflex must be acted upon immediately, it may not indicate full consciousness but the return of this reflex after stunning is a sign of some brain function returning and it indicates the possibility that consciousness may also be returning.	Mechanical, Electrical, Controlled Atmosphere Stunning
Dilated pupils	An indicator of onset of brain death.	Mechanical. Electrical, Controlled Atmosphere Stunning
Complete muscle relaxation	The tetanus seen at the exit of a waterbath stunner will soon disappear and a total relaxation in the carcass will follow with drooping of the wings.	Electrical, Controlled Atmosphere Stunning
Absence of response to comb pinch	Response to comb pinching is not a reliable indicator of state of consciousness following electrical stunning. This response may also not be a reliable indicator of return of consciousness with carbon dioxide stunning, as the induced analgesia associated with CO_2 may last longer than the period of unconsciousness.	Mechanical, Controlled Atmosphere Stunning (except CO_2 stunning)

References and further reading

1. EFSA Scientific Opinion on electrical requirements for poultry waterbath stunning equipment: http://www.efsa.europa.eu/sites/default/files/scientific_output/files/main_documents/3745.pdf

2. Hindle VA, Lambooij E, Reimert HGM, Workel LD, Gerritzen MA (2010). Animal welfare concerns during the use of the waterbath for stunning broilers, hens, and ducks. Poultry Science 89(3): 401-412.

3. Gentle MJ, Tilston VL (2000). Nociceptors in the legs of poultry: implications for potential pain in pre-slaughter shackling. Animal Welfare 9: 227-236.

4. Compassion in World Farming document on Improving Electrical Waterbath Stunning: http://www.compassioninfoodbusiness.com/media/7425704/summary-improving-electrical-waterbath-stunning.pdf

5. European Union Council Regulation (EC) No 1099/2009 on the protection of animals at the time of killing: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R1099&from=EN

6. Humane Slaughter Association Guidance Notes on the Electrical Waterbath Stunning of Poultry: http://www.hsa.org.uk/downloads/hsagn7electricalwaterbathpoultry1.pdf

7. Topkip head-only electrical stunning system: www.topkip.com

8. Dutch Visions Solutions: www.dutchvisionsolutions.com

9. Gerritzen MA, Reimert HGM, Hindle VA, Verhoeven MTW, Veerkamp WB (2013). Multistage carbon dioxide gas stunning of broilers. Poultry Science 92(1): 41-50.

10. Abeyesinghe SM, McKeegan DEF , McLeman MA, Lowe JC, Demmers TGM, White RP, Kranen RW, Bemmel H van, Lankhaar JAC, Wathes CM (2007). Controlled atmosphere stunning of broiler chickens. I. Effects on behaviour, physiology and meat quality in a pilot scale system at a processing plant. British Poultry Science 48(4): 406-423.

11. McKeegan DEF, Abeyesinghe SM, McLeman MA, Lowe JC, Demmers TGM, White RP, Kranen RW, Bemmel H van, Lankhaar JAC, Wathes CM (2007). Controlled atmosphere stunning of broiler chickens. II. Effects on behaviour, physiology and meat quality in a commercial processing plant. British Poultry Science 48(4): 430-442.

12. Gerritzen MA, Lambooij E, Hillebrand SJ, Lankhaar JA, Pieterse C (2000). Behavioral responses of broilers to different gaseous atmospheres. Poultry Science 79(6): 928-933.

13. Mackie N, McKeegan DEF (2016). Behavioural responses of broiler chickens during low atmospheric pressure stunning. Applied Animal Behaviour Science 174: 90-98.

14. Techno Catch Low Atmosphere Pressure System: http://www.chickencatcher.com/laps

15. EFSA Scientific Opinion on the use of low atmosphere pressure system (LAPS) for stunning poultry: http://www.efsa.europa.eu/en/efsajournal/pub/3488

16. Gregory NB and Wotton SB (1990). Comparison of neck dislocation and percussion of the head on visual evoked responses in the chicken's brain. Veterinary Record 126: 570-572.

17. Grandin T (1997) Cardiac Arrest Stunning Of Livestock And Poultry With 1997 Updates. Advances in Animal Welfare Science. M.W.Fox and L.D.Mickley 1985/86 (Editors) Martinus Nijhoff Publisher. http://www.grandin.com/humane/cardiac.arrest.html

18. Grandin T (2010) Recommended Animal Handling Guidelines and Audit Guide for Cattle, Pigs, and Sheep (2005 Edition, with 2007 and 2010 Updates) American Meat Institute Foundation: www.grandin.com/RecAnimalHandlingGuidelines.html

OIE Guidelines for the Slaughter of Animals. Terrestrial Animal Health Code 7.5.1: http://www.oie.int/index.php?id=169&L=0&htmfile=chapitre_aw_slaughter.htm