

HSA International Conference: Livestock Welfare during Transport, Marketing & Slaughter

 30 June & 1 July 2022

 Edinburgh, UK

 www.hsa.org.uk/edinburgh22

 #HSA2022



Scientific Programme

Welcome to the UFAW International Conference 2022

We are delighted to welcome you to Edinburgh for the Humane Slaughter Association (HSA)'s International Conference 2022: Livestock Welfare during Transport, Marketing and Slaughter.

Our first major conference in six years will give attendees the opportunity to present their work, and to network and socialise in person, something which we have all undoubtedly missed during the COVID-19 pandemic. For those colleagues who are unable to travel to Edinburgh, we are pleased to be able to livestream the talks and make them available 'on demand' online after the event.

The programme features talks covering the welfare of animals during transport and the pre-slaughter period, the welfare of animals during stunning, slaughter and killing as well as novel developments in these areas. Presentations cover a wide range of species, with two sessions focussing on the welfare of aquatic species at slaughter, including crustaceans and cephalopods. With both decapod crustaceans and cephalopod molluscs having been very recently recognised as sentient in UK law, it is important that we know how to protect their welfare.

We are delighted to be able to share the very latest developments in humane slaughter and transport with colleagues. It is heartening to see so much excellent research dedicated to improving the welfare of food animals 'beyond the farm gate'.

We would like to thank all those who are contributing to the meeting, as speakers, poster presenters and chairs, and the delegates from the 15 countries who are attending. We hope that you have an informative and enjoyable meeting.

We would also like to thank Sam Griffin, Jane Moorman and Tina Langford at the HSA office for working tirelessly behind the scenes to ensure the event runs smoothly.

Finally, please remember to fill in the short, online feedback form after the event and if you have any specific comments, please contact events@hsa.org.uk.

Huw Golledge, Birte Nielsen, Susan Richmond, Charlie Mason and Luisa Dormer
HSA Organising Committee

The Humane Slaughter Association (HSA)

The HSA is an international UK-based, independent charity and membership society. We are concerned exclusively with promoting evidence-based humane treatment of all food animals during transport, slaughter, killing for welfare reasons or disease control, and at markets.

We work through research, education, training and promoting technical advances to bring real, practical and lasting improvements in food animal welfare.

The HSA is funded solely by donations and legacies from members and supporters. Please help us to continue to make practical and lasting improvements to animal welfare beyond the farm gate by [becoming a member](#) or [donating to support our work](#).

Caring beyond the farm gate

Growing numbers of us are concerned about the welfare of animals that provide us with food and other products. Whilst many people recognise the importance of a good life whilst on the farm, animals may also face welfare challenges 'beyond the farm gate'. At the HSA, we play a vital role in promoting, developing and advancing animal welfare for the humane transport, slaughter or killing of all livestock animals by:

- funding innovative research projects to actively look for ways to ensure that the welfare of farmed animals is maximised beyond the farm gate;
- promoting practical and evidence-based solutions, offering expert advice and guidance to livestock producers, regulators and consumers, leading to real-world improvements for farmed animals; and
- collaborating with all those seeking to provide practical evidence-based approaches to maximise animal welfare during transport and at the time of killing.

Join the HSA today!

By joining the HSA, you will help us to continue to make practical and lasting improvements to animal welfare beyond the farm gate.

Individual membership is just £15 annually (£5 for students) and we will keep you updated on our activities and how your support is making a difference.

www.hsa.org.uk/support/memberships

Conference venue:

Royal College of Physicians of Edinburgh

11 Queen Street, Edinburgh, EH2 1JQ

The conference will take place in the Great Hall of the Royal College of Physicians of Edinburgh (RCPE) in the centre of the city. The New Library will host the coffee breaks and lunches as well as the drinks reception for delegates on the evening of 30th June.

Registration:

Registration will take place in the lobby of the RCPE from 8.00am on Thursday 30th June.

On registering, delegates will receive a timetable and a name tag. The name tag will allow delegates access to the meeting, and to lunch and refreshments. Please ensure you wear your lanyard and name tag at all times. Please be advised that the lanyards used for the name tags are made from recycled plastic, and the plastic slips have been cleaned and are being reused from previous events. Please put your name tags in the box provided at the end of the conference to allow us to reuse them at future events.

Please note that only delegates that are registered can attend the scientific programme. Registration is for an individual, not an institution and is not transferable, unless this has been agreed in advance with HSA.

The conference abstract booklet will only be available online, so if you wish a hard copy then you will need to print it out in advance.

Delegates with any general questions or queries should address these to the staff at the registration desk, in the lobby, in the first instance. Cloakroom facilities are available on request.

The conference programme is packed full of interesting talks and delegates are requested to take their seats in plenty of time before the start of each session. These will start promptly at the time indicated in the programme.

Catering:

Tea, coffee and lunch will be served in the New Library at the times indicated in the timetable.

Internet access:

To access free Wi-Fi during the meeting, connect to the following:

Network name: RCPE-WiFi

Password: chiron1681

Photography and video:

We will be taking photographs and recording videos throughout the conference. If you do not wish to be filmed or photographed, please let a member of staff know at registration.

Delegates are kindly requested to not take multiple photographs or record talks during the conference as this is distracting for others. Please respect presenters' wishes should they request certain material or slides shown not to be copied, photographed or shared on social media.

Social media:

The hashtag for the conference is **#HSA2022**

Safety:

In the event of a fire or other emergency, please leave via the nearest emergency exit. Delegates should assemble at No 14 Queen Street, to the left of the RCPE. A check that everyone attending the conference is present will then be made. Do not return to the building unless authorised to do so.



Scientific Programme:
Talks

Timetable and Speaker Abstracts



Timetable of event

Thursday 30th June

All timings are GMT+1 / UTC+1/ BST

08.00 - 08.50 Registration

08.50 - 09.00 **Welcome and Introduction:** Huw Golledge (*HSA*)

09.00 - 10.35 **Session One: Welfare during stunning, slaughter and killing**

09.00 - 09.35 **Keynote Speaker: Meeting the needs of Consumers in an evolving market**
Will Jackson (*Agriculture and Horticulture Development Board (AHDB), UK*)

09.35 - 09.50 **AI4Animals: Using AI to significantly increase the effectiveness of camera surveillance in slaughterhouses**
Carlos Morales (*Deloitte, Netherlands*)

09.50 - 10.05 **Movements after captive-bolt stunning in cattle in relation to possible animal and process related impact factors**
Karen von Holleben (*BSI Schwarzenbek, Germany*)

10.05 - 10.20 **A systematic review of equid welfare at slaughter: existing evidence and evaluation of animal welfare indicators**
Kate Fletcher (*Royal Veterinary College, UK*)

10.20 - 10.35 **Inter-observer repeatability of indicators of consciousness in broiler chickens after waterbath stunning**
Alexandra Contreras-Jodar (*Institute of Agrifood Research and Technology (IRTA), Catalonia, Spain*)

10.35 - 11.00 **Break**

11.00 - 12.30 **Session Two: Aquaculture Part One**

11.00 - 11.40 **Keynote Speaker: Do crustaceans feel pain, and should they be treated with care at slaughter?**
Bob Elwood (*Queen's University Belfast, UK*)

11.40 - 12.00 **Bringing humane slaughtering to cephalopod molluscs: an integrative approach**
Giovanna Ponte (*Association for Cephalopod Research 'CephRes', Italy*)

12.00 - 12.10 **Welfare of saltwater fish in Hong Kong wet markets**
Desiree Hung (*City University of Hong Kong*)

12.10 - 12.30 **In-water electrical stunning for humane slaughter of farmed fin fish**
Jimmy F Turnbull (*University of Stirling, UK*)

12.30 - 13.30 **Lunch**

Thursday 30th June

All timings are GMT+1 / UTC+1/ BST

13.30 - 15.00 Session Three: Aquaculture Part Two

- 13.30 - 13.45 **The assessment of dry electric stunning as a commercial method for the humane dispatch of farmed White Leg shrimp (*Litopenaeus vannamei*)**
Ben Weis (*Tesco PLC, UK*)
- 13.45 - 14.10 **Humane slaughtering of Snow crab (*Chionoecetes opilio*)**
Ragnhild Aven Svalheim (*Norwegian Institute of Food, Fisheries and Aquaculture Research, Norway*)
- 14.10 - 14.30 **Systematic review and feasibility study of humane stunning or stun/killing of wild-caught fish in commercial fisheries**
Nilantha Jayasuriya (*Harper Adams University, UK*)
- 14.30 - 14.45 **How to achieve a transition in aquaculture fisheries with regard to animal welfare**
Michelle Boonstra (*Good Fish Foundation, Netherlands*)
- 14.45 - 15.00 **Update on the UFAW Journal Animal Welfare**
Huw Golledge (*UFAW, UK*)
- 15.00 - 15.30 **Break**

15.30 - 17.20 Session Four: Stunning developments

- 15.30 - 16.10 **Keynote Speaker: Development and application of the Demonstration of Life protocol: An assurance framework for stunned halal slaughter**
Claire White (*National Farmers' Union (NFU), UK*)
- 16.10 - 16.25 **Assessment of the effectiveness and humaneness of upright restraint and stunning of broilers**
Troy J Gibson (*Royal Veterinary College, UK*)
- 16.25 - 16.45 **Improving the effectiveness and humaneness of head-only electrical stunning of turkeys**
Carlos Rebelo (*Royal Veterinary College, UK*)
- 16.45 - 17.00 **Stunning method for pigs: Views on where to prioritize future research**
Dorte Schrøder-Petersen (*Danish Technological Institute DMRI, Denmark*)
- 17.00 - 17.15 **Improved methods for stunning pigs with foam; Effects of repetition and scent on pig reaction to foam**
Miranda Blad (*Swedish University of Agricultural Sciences, Sweden*)
- 17.15 - 17.20 **Close of session**
- 17.20 - 19.00 **Drinks reception**

Friday 1st July

All timings are GMT+1 / UTC+1/ BST

09.00 - 09.10 **Introduction to meeting**

09.10 - 10.20 **Session Five: Humane Slaughter Award presentation**

09.10 - 09.15 **Award presentation to Dr Mette S Herskin**

09.15 - 10.00 **The case of the cull sow**

Mette S Herskin (*Aarhus University, Denmark*)

10.00 - 10.20 **Q&A Session with Mette S Herskin**

10.20 - 11.00 **Break**

11.00 - 12.55 **Session Six: Welfare during transport and the pre-slaughter period**

11.00 - 11.15 **Farm animal transportation regulations: time for a change?**

Eugénie Duval (*University of British Columbia, Canada*)

11.15 - 11.30 **European livestock drivers' knowledge about and experience with animal welfare and the EU transport regulation (1/2005)**

Kirstin Dahl-Pedersen (*University of Copenhagen, Denmark*)

11.30 - 11.45 **Condition of bob-veal calves on arrival at abattoir in Ohio**

Zachary England (*Ohio State University, USA*)

11.45 - 12.05 **Eliminating discretionary deaths in the cull sow transport network**

Ben Peyer (*Johnsonville LLC, USA*)

12.05 - 12.20 **The post-egg phase: welfare during pre-slaughter**

Anneleen Watteyn (*Flanders Research Institute for Agriculture, Fisheries and Food, (IVLO), Belgium*)

12.20 - 12.35 **The on-farm slaughter procedure leads to increased animal welfare in pigs**

Roxana Amerie (*Pisa University, Italy*)

12.35 - 12.50 **Abattoir inspection as early warning system to improve pig welfare at farm level**

Marta Comin (*University of Milan, Italy*)

12.50 - 12.55 **Closing of conference**

12.55 - 13.30 **Lunch served and farewells**

MEETING THE NEEDS OF CONSUMERS IN AN EVOLVING MARKET**Will Jackson**

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The presentation will look at the evolving consumer landscape highlighting current and predicted consumer trends following the easing of Covid-19 restrictions. The session will also explore key reputational topics such as health, environment, animal welfare and trust in the industry. The session will also highlight the importance of maintaining and building consumer trust, demonstrating where farming values (animal welfare, environmental stewardship and expertise) are shared with consumers.

A study from AHDB/Blue Marble in August 2021 showed that the humane treatment of farm animals has joined the environment, rising energy costs, Covid-19 and the state of the NHS as the topmost tier of societal concerns with 40% expressing they are very concerned - up 4%pts since last year. This is supported by IGD data that suggests 86% of people believe welfare of animals is important to them.

Key shopping behaviour will be highlighted and meat consumption performance trends picked out. As the cost of living dramatically increases and consumers feel a degree of financial pressure not experienced since the 2008 financial crisis, the session will explore consumer confidence and the effect on consumer behaviour. Alongside this prior to the pandemic research from Kantar Worldpanel showed that claimed meat consumption was declining amongst the British population. Typically main meals cooked at home are dominated by meat, fish and poultry with 60% of all main meals occasions including these proteins according to Kantar. The ongoing disruption of Covid put a brake on this trend as the numbers of “flexitarians” or those consciously reducing their meat and dairy consumption actually fell. We look at how this has changed as normality has returned and what may happen moving forwards

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AI4ANIMALS: USING AI TO SIGNIFICANTLY INCREASE THE EFFECTIVENESS OF CAMERA SURVEILLANCE IN SLAUGHTERHOUSES

Carlos Morales and Sjors Broersen

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Slaughterhouses are inherently stressful for animals. In addition, due to the large number of animals handled and the education required to act according to welfare protocols at often dated plants, the welfare of animals can be at risk.

To monitor and improve how animals are handled at abattoirs, many slaughterhouses have opted to install CCTV . In some countries this is mandatory (e.g. the UK) while in others is promoted by government and NGOs (e.g. the Netherlands).

As a result, many hours of video footage are recorded. However, even though the camera might record animal welfare issues, only a random and limited selection of the recording are reviewed. Therefore, the improvement potential for animal welfare and handling at slaughterhouses is not reached.

In order to make camera systems more effective, AI4Animals has been developed. This was done in collaboration with Deloitte, the Dierenbescherming (leading Dutch animal welfare NGO), Eyes on Animals (Dutch animal welfare NGO) and Vion, a large meat producer headquartered in the Netherlands.

AI4Animals uses computer vision (deep learning) technology to automatically detect animal welfare risk events from hours of CCTV footage recorded in slaughterhouses. It detects events specific to slaughterhouse processes, e.g. signs of life after stunning and bleeding and emergency stunning / handling errors in the offloading process. These events are then provided to slaughterhouse's animal welfare officers for review, in order to identify and implement improvement measures.

The system is operational in slaughterhouses in the Netherlands and Germany, with more countries and slaughterhouses to follow in the near future.

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MOVEMENTS AFTER CAPTIVE-BOLT STUNNING IN CATTLE IN RELATION TO POSSIBLE ANIMAL AND PROCESS RELATED IMPACT FACTORS

Anika Lücking and Karen von Holleben

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Since ban of pithing in the EU for slaughter of cattle and small ruminants from 2001 onwards, movements in cattle after captive bolt stunning are more evident. Consequently sticking may be delayed and stunning effect may be questioned (e.g. in the context of video surveillance). Our aim was to describe and categorize movements with regard to what can be expected and potential impact factors, e.g. animal related, incl. reduced stunning effect, and process related, incl. key parameters of the stunners.

In 2020/21 we investigated 2891 cattle (1484 bulls, 909 cows, 498 heifers) mostly Black Holstein (42%), Flecked (19%) and crossbreeds (20%) during routine slaughter in 5 plants (line speed 50-72/h), all except one using close head restraint. 2160 cattle were stunned by pneumatic guns (Jarvis USSS-21; EFA VB315), 731 by cartridge fired (Schermer KS, KR, KL). Av. stun-to-chest-stick time was 45s (38–51s). We documented stunning effect incl. 2nd shots, and examined position and angle of shots by introducing a stick into the skull hole. Movements were recorded by action cams (Apeman®A100) up to at least 4 min. after sticking and analysed during the process intervals “landing”, “hoisting”, “sticking”, “1st”, “2nd”, “3rd” and “4th min. of bleeding”. We defined the following categories:

- Hind leg-Kicking (KHL);
- Twitching (TW): >1 front or hind leg move uncontrolled/asynchronously;
- Body arched to side (BS);
- Body arched ventrally (BV);
- Front leg moves: bending (BFL), lifting (LFL);
- Stretching of unshackled hind leg (SHL).

At landing more cows (49%) and heifers (37%) moved than bulls (19%), predominantly showing KHL and TW (mostly intense = frequency >1/s, >5s long), shackling often being impeded. At hoisting more females (H52%, C45%) moved than bulls (40%), showing mainly moderate KHL and TW, BS, BFL or SHL. At sticking mostly KHL, BV and BFL/LFL were seen in 76% bulls, 77% heifers and 47% cows. During bleeding less cows’(62%) legs moved than heifers’(78%) or bulls’(70%). Most frequently, movements occurred at sticking and min.1 of bleeding, decreasing markedly thereafter, last ones seen in min.8 after sticking. Only 6.6% cattle showed no movements at all. Statistical analysis showed increasing effects on movement frequency/intensity for cows at landing and for Black Holstein during early process intervals and decreasing effects for slaughter weight, Brown Swiss or Flecked.

Regarding key parameters, cattle moved more and more intensely if shot by cartridge driven guns. Bolt extension length (range 8-12cm) had a slightly decreasing effect, whereas bolt velocity possibly increased. No relation between movements and stunning effect was found, but only 10 cattle (0.35%) were judged insufficiently stunned and 9 doubtful, two of the former might have kept or regained consciousness for a few seconds. Possible reasons were deviation >3cm in shooting position or >15° from 90° angle to the forehead or lack of kinetic energy. Although position/angle deviated only rarely, we got indications for a thereby increasing effect on movements.

The project is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support programme.

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A SYSTEMATIC REVIEW OF EQUID WELFARE AT SLAUGHTER: EXISTING EVIDENCE AND EVALUATION OF ANIMAL WELFARE INDICATORS

Katharine Fletcher¹, Georgina Limon^{1,2}, Louise Whatford¹, Andy Grist³, Toby Knowles³ and Troy Gibson¹

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Guidance surrounding equine slaughter varies globally, if it exists at all in some countries, and lacks published evidence. This limits practical application, causing industry confusion and potentially compromising welfare, considering millions of equids are slaughtered each year. To protect the welfare of increasing numbers of equids facing slaughter, robust, evidence-based guidelines are needed to ensure species-specific considerations in abattoirs.

The aim of this evaluation was to conduct a systematic review of existing research in this field and to determine what reliable and feasible indicators have been validated to develop a protocol for the assessment of equid welfare at slaughter.

Four databases were searched: PubMed, CAB Abstracts, Science Direct and Google Scholar, using a combination of different search terms. Predetermined inclusion and exclusion criteria were applied with full texts assessed for reliability, repeatability, potential bias and study design. Each welfare indicator was assessed on feasibility for abattoir observations and level of invasiveness.

In total, 2,194 articles were screened, and an additional 35 articles were identified via peer-networks and after a snowball search of reference lists. After screening, 105 studies were identified for inclusion in the review. Of these, 101 were peer-reviewed journal articles and 4 were grey literature. Thirty-two looked at equid slaughter specifically, with conflicting findings regarding slaughter efficacy but agreement that horses showed stress-related behaviour prior to slaughter. Most studies (n=76, 72%) were conducted in countries where equid slaughter is not extensive. Welfare indicators were identified with 39 deemed feasible for use as non-invasive or pathological measures in an abattoir setting.

This review found a severe shortage of published research assessing equid welfare at slaughter, most notably in donkeys or in countries with the highest production rates of horse and donkey meat. This highlights the urgent need for research in this area to develop an evidence base for improving guidance surrounding equid welfare at slaughter.

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INTER-OBSERVER REPEATABILITY OF INDICATORS OF CONSCIOUSNESS IN BROILER CHICKEN AFTER WATERBATH STUNNING

Alexandra Contreras-Jodar¹, Aranzazu Varvaró-Porter¹, Virginie Michel² and Antonio Velarde¹

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One of the main challenges in monitoring the state of consciousness in broiler chicken after waterbath stunning is the selection of the animal-based indicators (ABI) ensuring consistency of controls. To be relevant, ABI should meet three requirements, validity, feasibility and repeatability. The validity and feasibility of ABIs have been assessed by EFSA (2013). However, it is pending to assess the repeatability so that can be proposed a refined and validated list. Thus, the main goal of the study was to assess the inter-observer repeatability of the most valid and feasible ABIs for the state of consciousness after water bath stunning in broilers both before bleeding (tonic seizure, breathing, spontaneous blinking and vocalisation) and during bleeding (wing flapping, breathing, spontaneous swallowing and head shaking) and the correlation among them.

This study compared the assessment of 3 observers in 5,241 broilers from 19 batches of 6 different slaughterhouses in two EU countries. Data were analysed at individual broiler level and the combination of crude percentage of agreement (PoA) and Fleiss' kappa (k) and its interpretation according to Fleiss (2003) was used to assess the inter-observer repeatability of the outcomes of some ABIs for the state of consciousness.

Before bleeding, the most repeatable ABI was vocalisation (PoA = 100%) followed by spontaneous blinking (PoA = 99.8%; k = poor), breathing (PoA = 98.9%; k = fair to good) and tonic seizure (PoA = 91.7%; k = fair to good). However, both vocalisation and spontaneous blinking were artificially highly repeatable as hardly ever were observed. On the other hand, absence of tonic seizure was the less repeatable and was not correlated to other ABI before bleeding probably because tonic seizure occurred in some birds while the bird was still in the water bath. Therefore, it seems difficult to rely on the absence of tonic seizure to assess consciousness. Thus, we recommend focusing on presence of breathing as indicator of consciousness. However, presence of spontaneous blinking and vocalisation, although hardly ever observed, should not be neglected as indicators of consciousness and ineffective stunning.

During bleeding, the most repeatable ABI was spontaneous swallowing (PoA = 98.84; k = poor), followed by wing flapping (PoA = 98.2%; k = fair to good), head shaking (PoA = 96.4%; k = fair to good), and breathing (PoA = 88.2%; k = fair to good). However, spontaneous swallowing is artificially repeatable as was the least observed indicator. Therefore, we recommend focus on presence of breathing, head shaking and wing flapping assessment although less repeatable. Sometimes birds showed simultaneously more than one outcome of consciousness being breathing and head shaking and breathing and wing flapping the most observed combinations. This work will serve at proposing a refined list of ABIs so that they can be used to assess the consciousness of broiler chickens in commercial slaughterhouses.

References:

EFSA (European Food Safety Authority). 2013. Scientific Opinion on monitoring procedures at slaughterhouses for poultry. EFSA Journal, 11(12):3521. Doi: <https://doi.org/10.2903/j.efsa.2013.3521>

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DO CRUSTACEANS FEEL PAIN, AND SHOULD THEY BE TREATED WITH CARE AT SLAUGHTER?**Bob Elwood**Queen's University Belfast, UK
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Animals face hazards that cause tissue damage and have rapid nociceptive reflexes that cause the animal to withdraw from the damaging stimuli. These nociceptive reflexes have a vital function because they are effective in reducing immediate tissue damage and nociception is widespread among metazoan animals. However, at least in humans, there is a second response to tissue damage that we call pain. The highly negative emotional experience of pain appears to cause long-term changes in motivation that modify the behaviour of the animal. Pain thus enhances long-term protection through behaviour modification so that the animal avoids situations that previously resulted in tissue damage and pain. The negative affective state of pain might also guide responses to the specific site of a wound that enhance recovery. These two aspects of the response to noxious stimuli make it difficult for us to investigate pain in non-human animals. Simply showing that animals respond to noxious stimuli by withdrawal tells us little about their capacity for pain because the reflex need not involve any central processing.

The possibility of pain in decapod crustaceans was long dismissed because they were said to respond to noxious stimuli purely by nociceptive reflex. Thus, there was no concern about suffering and no protection was offered to these animals when used for human food. This talk considers behavioural and physiological criteria that might help to distinguish nociception from pain in crustaceans. Rapid avoidance learning and prolonged memory indicate central processing rather than mere reflexes and are consistent with the experience of pain. Complex, prolonged grooming or rubbing may be beyond mere reflex and demonstrate an awareness of the specific site of stimulus application. Trade-offs with other motivational systems indicate central processing, and a noxious experience might affect behaviour for at least 24hrs. Recent evidence of fitness-enhancing, anxiety-like states is also consistent with the idea of pain. Physiological changes in response to noxious stimuli mediate some of the behavioural change, and some of these physiological changes are due to the noxious stimulus not to the behavioural response. Thus, available data go beyond the idea of just nociception but the impossibility of total proof of pain that is like our own feelings means that pain in crustaceans is still disputed. However, definitions of pain in animals should not be based on human experience. Rather they should focus on the behavioural and physiological responses that can be measured and may function to increase fitness. Methods of killing decapods should take the possibility of pain and suffering into account. Dismembering live animals and boiling live animals should be avoided.

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BRINGING HUMANE SLAUGHTERING TO CEPHALOPOD MOLLUSCS: AN INTEGRATIVE APPROACH

Giovanna Ponte, Eleonora Maria Pieroni, HSA-Ceph Project Members

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Together with the overwhelming majority of marine animals fished as seafood globally, cephalopod molluscs (cuttlefish, squid and octopus) are captured by a variety of fishing methods, and once on the boat there are no specific or systematic slaughter practices for them; animals are unable to breathe, and die due to anoxia. As a commercial food source, these animals represent 5% of the total marine catch volume in the world (4% of the total volume of fisheries trade). It is noteworthy to remind that these are the sole invertebrate animals included in Directive 2010/63/EU and are at the centre of an interesting scientific and public discussion around their sentience, remarkable cognitive faculties, and possession of a form of primary consciousness that in many ways parallels that of mammals.

The mission of the HSA Ceph 1/2019 project is to develop a pipeline for the efficient humane slaughter of cephalopod species of commercial interest, largely used by humans as food (*Sepia officinalis*, *Loligo vulgaris*, *Octopus vulgaris*; to mention some). We focus on two methods: mechanical- and electrical-stunning and assess the efficacy of each technique, particularly with regard to the time elapsed until loss of consciousness. Monitoring of the main physiological and biological responses of animals to stunning is also at the centre of our activity. We adopt the ESFA eligibility criteria for assessing outcome. Our overarching vision is to instil and improve cephalopod welfare, thus reducing the risk of continue to use inhumane killing methods when cephalopods have to be processed for human consumption and other needs.

Activities carried out till now allowed us **a.** to develop FELASA recommendations for capture and transport (C&T) of cephalopods for scientific purposes, and **b.** to design a FELASA training program for collectors, shippers and transporters. This aims at increasing our chances of efficient interaction with fishermen communities, to provide guidance and training, and to facilitate collaborative attitude among different stakeholders. We also contributed at informing the European Commission about:

- c.** mandate minima requirements for housing and care of cephalopods (inclusion in the revision of Annex III of the Directive 2010/63/EU), and
- d.** recommendations for humane methods of killing of cephalopod molluscs (inclusion in Annex IV).

These recommendations are based on our activities, experience, and consensus-based approach, and should be considered important outcomes of the HSA Ceph project.

Data collected till now revealed:

- e.** Electrical bioimpedance of octopus appears distinct from that of cuttlefish and squid, thus suggesting species-specific differences for electrical stunning
- f.** Body size at capture of animals is also another factor of influence
- g.** Mechanical stunning (penetrating and concussing) is efficient with cuttlefish and squid, but require further tuning for octopus (body size, species differences), and target recognition methods
- h.** Chilling (as confirmation of death method – a practice adopted by fishermen) may not be required after mechanical stunning
- i.** Methods for assessing EEG during stunning have been developed by correlating brain areas and their peripheral extensions (pallial nerve in the mantle or arm nerve cord)
- j.** We estimated fishermen C&T methods and scale operations and their geographical differences to start evaluating applicability of the two stunning methods.

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WELFARE OF SALTWATER FISH IN HONG KONG WET MARKETS**Desiree Hung, Sophie St-Hilaire, Kwok Zu Lim, Chi Fai Leung, Stephen Chi Ho Chan**

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The welfare of saltwater fish species in Hong Kong wet markets is often overlooked. The objective of this study was to investigate the welfare of fish in these types of markets and determine if any welfare indicators were associated with water quality parameters, and stocking density. During our visit to 15 stalls in June-July 2021, most tanks did not have fish with lesions and overall mortality in the tanks was very low. Only 3 dead fish were observed. Common observations during visual inspection of fish health were ulcerations on the facial and lateral area, fin erosion and loss of equilibrium. The percentage of tanks with each health issue observed was 34% (n = 16), 19.1% (n = 9), 27.7% (n = 13) and 46.8% (n = 22) respectively. Results from water quality parameters in 47 tanks from the 15 stalls were within normal range for most warm water fish species, with only a few outliers for temperature, total ammonia, and salinity. However, all stall owners used supplemental air oxygen in their tanks. Stocking density was categorised into one of three groups, with less than half of the tanks classified as low density (48.9%, n = 23). We found a significant association between higher stocking density scores and total ammonia levels, facial and lateral ulcerations, and fin erosion. This is consistent with physical damage from overcrowding. Loss of equilibrium was associated with water quality parameters (dissolved oxygen (DO), pH) but the precise mechanism for the issue was not clear. We hypothesised that the equilibrium issue may be related to a carbon dioxide problem given the relationship with pH, but we could not measure this dissolved gas during our visits to confirm. Overall, the welfare of fish in the stalls we visited was acceptable, and the few health issues can likely be addressed directly or indirectly by reducing density of fish in the tanks. Further investigation on optimal threshold stocking density suitable for Hong Kong fish stalls considering economic profit, available space, varying species of fish and fish welfare would be necessary.

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IN-WATER ELECTRICAL STUNNING FOR HUMANE SLAUGHTER OF FARMED FIN FISH**Jimmy F Turnbull¹, Nathan Pyne-Carter², Maureen A Ellis¹, Jenny A Bousema², Toby G Knowles³
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It has been estimated that over 1 billion people rely on fish as their primary source of protein and the UN anticipates a further 18% increase in fish consumption between 2018 and 2030. As a result a huge number of fish are killed for human consumption every year. While estimates are highly uncertain, the total number could be in the 10s or 100s of billions of fish per year. Only a very small proportion of these are slaughtered humanely. While there has been a great deal of progress in the farmed salmon and trout sectors, progress in other sectors has been limited. Globally, most farmed fish are left to suffocate in air or on ice, this is also the fate of many wild captured fish and in some cases wild fish may even be gutted and filleted alive. A current Humane Slaughter Association funded project on fin fish, aims to examine the validity of methods of stunning and achieve uptake of best practice across a wide range of species and geographic regions.

The project focuses on electrical stunning as the most promising method of stunning fish in terms of both welfare and practicality. The main alternative is manual or mechanical percussive stunning. Manual percussive stunning is subject to human error. Mechanical systems require careful set up and monitoring and are only reliable if the batches of fish are uniform in size and conformation. If correctly delivered a blow to the head can effectively render some species of fish permanently insensible, however, other species such as some catfish (*Clarius* spp) and tilapia have heavily protected brains making this form of stunning less effective. The scientific challenges in this project include assessing consciousness in fish, assessing efficacy of stunning for very large number of fish in the production environment and the substantial differences between the various species of farmed fish. Existing methods for assessing consciousness in fish are based on response to stimulation and behaviour, are used for anaesthesia and at slaughter. However, there are species variations in both behaviour and response to stimulation and even with the most well studied species they only allow a very coarse classification of stage of anaesthesia. We are using conventional approaches with analysis of background EEG, Visual and Somatic Evoked Responses in an attempt to triangulate on state of consciousness.

However, scientific outputs alone are not an effective way to change the behaviour of those harvesting farmed fish. For this reason, the project is a close collaboration between industrial partners and academics. The main industrial partner has already successfully installed stunners in a wide range of fish slaughter facilities and has a network extending from producers through to retailers. The project is developing and validating stunning equipment and then providing demonstration systems to potential early adopters. Not only has this strategy been proven to improve uptake, but it will also allow real world data to be collected on low prevalence issues with product quality. The presentation will provide a review of the background and an update on progress.

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THE ASSESSMENT OF DRY ELECTRIC STUNNING AS A COMMERCIAL METHOD FOR THE HUMANE DISPATCH OF FARMED WHITE LEG SHRIMP (*LITOPENAEUS VANNAEMI*)

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Commercially the most common method of stunning shrimp species is the use of ice slurry. Ectotherms become torpid when cooled below 4°C but the response is not instantaneous and there is debate as to whether both neuronal and sensory functions are sufficiently down-regulated to ensure that the animal does not experience discomfort during the process. The availability of electric dry stunning technology (successfully used across a range of aquaculture species in the Tesco supply base) was considered to have potential to improve efficiency and efficacy of stunning at harvest of crustacea. Commercially however, it has not been determined to date whether shrimp could be electrically stunned during harvest under parameters which balance effectiveness of stun, with product quality (i.e. limiting the frequency and severity of electrical burn in finished product).

The current trial was undertaken in the Vietnam supply base during harvest of commercially farmed White leg Shrimp (*Litopenaeus vannamei*) using an Optimar stunner (Optimar AS www.optimar.no). The model used had not been modified for shrimp but operating parameters under test were consistent with those reported as effective in independent research. During harvest, shrimp were pumped and discharged onto the stunner conveyor at a throughput rate of 10 tonnes per hour. Shrimp were stunned when simultaneously establishing contact between both conveyor and paddle electrode, or through shrimp-to-shrimp contact across paddle and conveyor electrode surfaces. A fixed frequency of 45hz was used for every batch processed but voltage was varied between 40-125 volts. Immediately post stun 50kg samples were assessed for:

- Effectiveness of stun (as indicated by co-ordinated leg movement)
- Stun damage (as indicated by surface discolouration and burning)

Voltage effects on stunning efficiency were fitted by an exponential trend line illustrating the greatest relative improvement occurred when increasing voltage from 40-60, resulting in an increase in average stunning efficiency from 91.3% to 96.9%. Further improvements can be effected at voltages above 75 volts but this is accompanied by a similarly exponential increase in the percentage of shrimp sustaining burns during the stunning process. Examination of a sub-sample of shrimp indicated that a variable proportion continued to demonstrate heart and gill bailer activity (indicative of neuronal and respiratory function) in the absence of co-ordinated leg movement. Typically, this was less than 5% of assessed animals. However, as electrical stunning was followed by transfer to ice slurry the subsequent thermal shock ensured no full return to consciousness. A majority of shrimp were in irrecoverable stun (stun-kill) on exit as evidence by transfer back to a controlled aqueous environment where none showed signs of recovery within the monitoring period i.e. 10 minutes 32 seconds. Electrical stunning can therefore be considered a commercially viable alternative for humane stunning of White Leg shrimp. Formal ethical approval was not required but best practice handling and processing requirements for crustacea was adhered to at all times.

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HUMANE SLAUGHTERING OF SNOW CRAB (*CHIONOECETES OPILIO*)**Ragnhild Aven Svalheim¹, Endre Grimsbø² and Bjørn Roth¹**¹ Nofima, Tromsø, Norway² The Arctic University of Norway, Teknologibyggget Klockargårdsbakken, Tromsø, Norway
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The snow crab fishery takes place in the Barents Sea far from land and therefore majority of the crabs are slaughtered on board the fishing vessels. The most common slaughter method is the use of a splitting machine. This machine works by fixating the crab's walking legs and claws and splitting the crab in two using either a knife blade or a water jet. Despite the widespread use of this method, there is little evidence as to whether this renders the crab unconscious, or if there could be alternative methods that may be more humane. In our study we aimed to investigate three different slaughter techniques (chemical, mechanical and electrical) and assess the welfare using behavioural and neurological (EEG of thoracic ganglion) measurements to examine response and loss of consciousness and death.

Three slaughtering techniques were tested; chemical, mechanical and electric. The chemical method was injecting saturated potassium chloride (KCl) directly into the heart using a syringe. Welfare was evaluated by scoring responsiveness of eyes, antenna, mandibula, chelae, walking legs, claw and tail along with EEG. The mechanical method was splitting the crab in two using a large kitchen knife. Welfare was evaluated as above. The electric stunning was carried out using a dry stunner 50 Hz, 220 V AC. The crab was placed on a metal plate and the electrodes were placed either on the carapace or fixated on the legs to simulate the splitting machine onboard fishing vessels.

Of the three methods, correct splitting gave what appeared to be a quick epileptic seizure followed isoelectric line indicating a cessation of nerve signal i.e. death. However, if the splitting was only slightly off the middle, signal would continue, even when the crab was non responsive during the behaviour tests. KCl had varying results from fast cessation of signal to continuing signal until euthanasia. Eyes, antenna, mandibula, chelae, walking legs, claw and tail were all negative on the responsiveness test, but EEG could still sometimes show signals during the test. Electrical stunning also gave epileptic seizure, but some individuals appeared to regain a "normal signal" after 3-4 minutes which coincided with increased response to stimulation, whereas other did not regain either normal signals or responsiveness. With electric stunning there was in general good correlation between behavioural response during stimulation and increased amplitude and frequencies of signal measured by EEG.

The preliminary data indicates that there is not always a good correlation between behavioural responses and neural activity (indication of potential consciousness) during slaughter of snow crab when using splitting or injection of KCl. Of the three methods, splitting and electrical stunning appears to be the most promising. We propose a combination of the two, - a stun splitter, to be a potential new and humane method for slaughtering snow crabs.

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SYSTEMATIC REVIEW AND FEASIBILITY STUDY OF HUMANE STUNNING OR STUN/KILLING OF WILD-CAUGHT FISH IN COMMERCIAL FISHERIES

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An estimated 0.9 to 2.5 trillion individual wild finfish are captured globally each year by commercial fisheries and destined for human or animal consumption. Evidence that fish are sentient and able to experience fear, pain and suffering has led to international recognition that there is a need to improve the welfare of fish for consumption, including at point of slaughter.

The World Organisation for Animal Health (OIE) and the European Food Standards Authority (EFSA) recommend as a general principle, that farmed fish for human consumption should be stunned before killing, and the stunning method should ensure immediate and irreversible loss of consciousness. If the stunning is not irreversible, fish should be killed before consciousness is recovered. The humane stunning methods that are recommended included; (1) electrical stunning, (2) percussive stunning, (3) spiking and coring and (4) free bullet. To date guidelines for the humane stunning of wild-caught fish are extremely limited.

Of the estimated 0.9 to 2.5 trillion individual wild finfish are captured globally, the majority are slaughtered using inhumane methods. Our estimates indicate that small pelagic species are generally caught in the greatest numbers globally. A systematic search for published and unpublished literature has shown that humane stunning has only been scientifically researched for a very small minority of wild-caught fish species. Evidence for implementation of humane stunning in commercial wild-caught fisheries is scarce and the implications of using such technologies on board fishing vessels have not been scientifically verified to safeguard fish welfare. Preliminary results from the feasibility analysis indicate that there is a growing interest in humane stunning of wild caught fish. The feasibility of stunning method depends on size of fishery, volume of catch, fishing gear used and target species. Lessons learnt from the aquaculture sector are highly likely to inform and develop humane stunning for the wild-capture sector but further research will be required to transfer these methods into wild capture fisheries where conditions are very different.

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HOW TO ACHIEVE A TRANSITION IN AQUACULTURE AND FISHERIES WITH REGARD TO ANIMAL WELFARE

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Interest in welfare of food animals that are reared or captured in an aquatic environment is accruing in Europe and countries such as New Zealand and Brazil. As response to these societal developments, various research projects were and have been initiated with a focus on technological solutions to prevent or mitigate welfare issues. However, in technological projects there may be a lack of focus on: acceptance of technological solutions by stakeholders; consumer studies; possibilities for a win-win benefit between welfare and running a business; and education of people who are working or have an interest to work in aquaculture and fisheries. This lack may hinder or even prevent a transition in the aquaculture and fisheries.

To achieve a transition in aquaculture or fisheries with regard to animal welfare theories of transitions processes are a valuable tool. Obviously, a holistic view on possible transition pathways is needed by using the multi-level perspective on transition theory of Geels. This multi-level perspective consists of three levels. In the first level alternatives in e.g. incubation rooms to current practices are developed. In the second level current practices are changed with respect to socio-technical aspects and at the third level long-term changes in society occur.

The case of improvement of animal welfare in aquaculture and fisheries should be analysed with regard to:

- support of stakeholders
- a win-win benefit with respect to animal welfare and operations in industry
- working conditions of staff in aquaculture and fisheries
- consumer acceptance and their willingness to pay for products that originate from processes during which animal welfare was improved
- study the possibilities of valorisation of these products
- assist consumers to make an informed choice with regard to a product that was processed using operations with a focus on improved animal welfare
- possibilities for assurance of the supply chain and traceability throughout all steps in the chain; when a consumer purchases a product for which it is claimed that welfare is improved, this claim is indeed justified
- transfer of knowledge by means of workshops and courses to educate people who are working in aquaculture and fisheries or will apply for a job in these industries.

To achieve a transition, it is essential that a project consortium is multidisciplinary, as it pursues an innovation that is multi-faceted; the innovation is not limited to only biological and technical aspects. Results obtained in a recently started project, which is aimed at on how to put stunning of captured plaice and turbot into practice aboard a Dutch fishing vessel, will be presented as case study. Our ongoing study on this transition process provides us expertise on the possible courses of the transition that is focused on fish welfare in demersal fisheries.

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DEVELOPMENT AND APPLICATION OF THE DEMONSTRATION OF LIFE PROTOCOL: AN ASSURANCE FRAMEWORK FOR STUNNED HALAL SLAUGHTER

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In April 2021, Minister Lord Goldsmith launched the UK Demonstration of Life protocol for sheep and goats; an assurance framework for the application of head-only electrical stunning in Halal slaughter. The protocol is the product of several years' development by a cross-industry stakeholder working group, led by Lord Sandy Trees and involving Halal certifiers, farming and veterinary membership organisations, the Food Standards Agency (FSA), AHDB and Animal Welfare Committee. Its background work and subsequent development was funded and supported by the Humane Slaughter Association. A formative component of this involved a scoping visit to New Zealand in February 2019 to understand their processing sector in the application of a similar government-supported framework for demonstrating recoverability of stunned halal processing.

Development of the protocol and its subsequent application has fostered greater positive collaboration between halal certifiers, the red meat sector stakeholders, and competent authority, going some way to address the disconnect acknowledged by researchers in 2017 (Fuseini, 2017). Discussing acceptance of stunning, and animal welfare more broadly, in a constructive and objective manner has led to a more positive dialogue on the processing of animals for consumption by people of faith. It has also established the principle of government-supported assurance frameworks, both in domestic and international markets.

The halal market for lamb is of strategic importance to the sheep industry and supply chain, estimating that over 20% of UK sheep meat is consumed by Muslims (EBLEX, 2010), particularly those cuts and carcasses less suitable for retail markets. Presently the global halal food industry is valued at £542 bn., increasing to £921 bn by 2050 (Global Islamic Finance Report, 2013). Following exit from the European Union, the UK is also seeking to negotiate free trade agreements with Muslim majority countries and the Gulf Cooperation Council (GCC), where assurance of halal standards is a fundamental requirement. Demonstrating assurance of halal food standards in both domestic and international markets is of increasing importance to the sector.

Demonstrating recoverability of stunned Halal sheep slaughter is an important component of quality assurance frameworks in major sheep-meat producing nations, including New Zealand. The ability to provide routine assurance to their international markets that stunning does not cause the death of the animal prior to slaughter is a cornerstone of acceptance of electrical head only stunning methods in halal production. In New Zealand, all sheep are stunned prior to slaughter and 90% of production is eligible for assurance under the government halal quality assurance framework. This facilitates export to 122 markets, including those where Halal assurance is mandatory, particularly Malaysia, United Arab Emirates (UAE) and China (Source: MPI Halal Assurance presentation, 2019).

In the UK, Halal slaughter with prior stunning is recognised in the standards of some halal certification bodies, with 95% of scholars considering it permissible when questioned - providing it did not cause death, physical injury or impair bleeding. More than half of consumers also confirmed the meat produced from such systems would be considered halal (Fuseini et al., 2017). Nevertheless, misconceptions about rationale for stunning and misunderstanding of their method of action have persisted, in the absence of mechanisms to assure recoverability.

Additionally, others recognise acceptability of stunning on condition that the main cause of death of the animal is

through blood loss, as opposed to stunning. Whilst papers have demonstrated that blood loss in sheep slaughtered for Halal consumption is not affected by slaughter with electric head-only stunning (Anil, M.H. et al 2004, Khalid R. et al 2015). Historically, it had not been possible to demonstrate recoverability of head only stunning methods during sleep slaughter since welfare at slaughter legislation does not permit animals to recover fully once stunned, and subsequent death by bleeding must occur without delay (DEFRA, 2015).

Development of an assurance framework where a small number of animals demonstrate the earliest signs of recoverability under observation, without return to full consciousness, was supported by halal certifiers, national stakeholders and the Animal Welfare Committee – an expert advisory committee to Defra. This enabled the competent authorities to permit its use in specific circumstances, under the supervision of a senior FSA Veterinarian, and in the presence of a participating certification body representative. Application for use of the protocol is supported by AHDB and subject to approval by the FSA. Both FSA, certifier and abattoir participants undertake mandatory externally accredited training prior to application and must follow a standard operating procedure specific to the abattoir.

Following launch of the protocol, it has been applied successfully in several abattoirs, also promoting ongoing discussion of assurance for faith consumption in other species. Availability of recoverable methods in all commercially slaughtered species may present a temporary barrier to further demonstration protocols, however the principles of government-supported assurance can still be considered in the context of the whole supply chain– similar the New Zealand Halal Notice. It is hoped that greater dialogue in these areas will serve to broaden understanding of halal requirements in all markets and increase assurance of faith consumers everywhere in UK products, in addition to strengthening relationships between the competent authority, veterinarians, certifiers and religious authorities.

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ASSESSMENT OF THE EFFECTIVENESS AND HUMANENESS OF UPRIGHT RESTRAINT AND STUNNING OF BROILERS

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The welfare issues associated with waterbath stunning are widely recognized. Although supplanted by control atmosphere stunning systems in some countries, worldwide waterbath stunning is still widely employed for secular and stunned halal slaughter. Shackling has been shown to cause pain and distress. While restraint in an inverted position (on shackle or in a cone) is an unnatural and stressful position for poultry. These issues are in addition to the widely reported welfare problems with waterbath stunning effectiveness. There is a recognized need for refinement of stunning restraint systems that remove the need of shackling and inversion of conscious birds. This study involved the assessment of proof of concept and the humaneness of a novel prototype upright restraint system incorporating constant current head-only electrical stunning.

A series of work packages were conducted to design, fabricate, and initially test the prototype with mannequins. This led to live broiler experiments examining: (1) optimisation of restraint without stunning; (2) behavioural and (3) electroencephalographic (EEG) assessment of stunning performance during upright restraint.

During the optimisation experiments, 50 slaughter weight broilers (2.6±0.4 kg) were assessed over multiple runs for behavioural signs of distress and discomfort associated with restraint. Modifications were made during the experiment to improve presentation of the birds. After accounting for liveweight and number of runs, each modification improved positioning of the birds, with alterations to restraining finger position, reducing the odds of head withdrawal (OR=0.1, P=0.05). There were no evident signs of excessive distress, discomfort or trauma associated with the restraint system, however there was an increase in vocalizations with each subsequent run that birds experienced (P=0.01). Electrical stunning was incorporated into the prototype. Behaviour during restraint/stunning and duration of unconsciousness with behavioural/brainstem indices (time to recovery) were assessed in 45 birds (2.6±0.3 kg) stunned with 400, 600 and 800 mA. The duration of induced unconsciousness was most variable in birds stunned with 400 mA (34±13, 8-50 seconds), while 800 mA caused severe convulsions with breast and wing bruising (n=8/10) and wing dislocation (n=1/10). It was found that 600 mA was most effective in producing a reliable stun (36±2, 27-49 seconds).

In conclusion, the prototype upright restraint system with 600 mA constant current head-only stunning, following in trial modifications was able to restrain and control stunning induced convulsions without causing signs of excessive welfare compromise and carcass damage. These findings suggest that upright restraint and stunning could improve the welfare of broilers during stunning compared to existing systems.

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IMPROVING THE EFFECTIVENESS AND HUMANENESS OF HEAD-ONLY ELECTRICAL STUNNING OF TURKEYS

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Current systems for electrical head-only stunning of poultry are commonly used by small scale producers, as they are relatively cost-effective, simple to operate and, because they are a reversible stunning method, can potentially be used for Halal slaughter. Nevertheless, it is anecdotally recognised that these systems and their associated electrical parameters are inefficient in inducing a state of unconsciousness lasting longer than the killing process.

To assess current electrical head-only stunning practices and equipment used in the sector, a survey was conducted on small scale producers in the UK to determine the most common head-only stunning systems. Based on these results a series of experiments were conducted to: (1) evaluate the effectiveness and humaneness of currently used systems; (2) develop and test new electrode designs; (3) refined electrical stunning parameters; and assess the influence of these new designs and parameters on (4) carcass and meat quality. Effectiveness of stunning was assessed with visual evoked potentials (VEPs) and behavioural/reflex indicators. Electrical current profiles were collected to monitor stunning and identify poor current applications. Carcass and meat quality was assessed with breast tissue pH, temperature, gross carcass lesions, haemorrhages, colour and tenderness.

Assessment of (1) currently used systems, found that VEPs returned later with the standard three pin (mean $25.5 \pm$ (SD) 11.2) compared to needle pin (14.4 ± 8.35 , $p = 0.023$) and single pin electrodes (12.00 ± 6.6 sec, $p = 0.021$). Based on these findings and cadaver trials, (2) three prototype/alternative electrode designs were tested (sharktooth, concave plates and wired mesh). Of these designs, the concave plate electrodes designed to conform to the head, resulted in VEPs returning at a later stage (30.5 ± 3.3 sec). This design was further tested with modification to stunning parameters to ensure a period of induced insensibility that outlasts the time to loss of sensibility by bleeding alone (set at 35 sec based on the literature). The minimum current required to induce this period of insensibility was 1200 mA for 4 seconds, producing a period of insensibility of 39.8 ± 2.6 sec. Finally, (4) carcass and meat quality were compared between the concave plates electrodes (1200 mA) and the best performing standard commercial system (3 pins electrodes, 400 mA). Between the systems there was no significant differences in carcass or meat quality.

In conclusion, the results suggest that the existing electrode designs and the minimum head-only electrical stunning parameters are insufficient to protect turkey welfare at the time of slaughter. Stunning duration, effectiveness and animal welfare can be improved with the new electrode designs and stunning parameters, without compromising carcass and meat quality.

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STUNNING METHODS FOR PIGS: VIEWS ON WHERE TO PRIORITIZE FUTURE RESEARCH**Joanna Klaaborg & Dorte Lene Schrøder-Petersen**

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Carbon dioxide (CO₂) stunning is the most common method used to commercially stun pigs. However, it is subject for discussion. Criticism derives from various stakeholders on the grounds that some pigs display an aversive response to high concentrations of the gas in the seconds before they lose consciousness. The European Food Safety Authority points out that the gasses used for stunning ought to be non-aversive, and they emphasized group-based gas stunning as an advisable principle from an animal welfare point of view. Even though groupwise CO₂ stunning to a large extent accommodates these criteria, Eurogroup for Animals proposes a ban of CO₂ stunning by 2025.

CO₂ stunning has been a focus area to the European Commission for a while and they will revise regulations on the protection of animals including at the time of killing by the end of 2023. This calls for an urgent discussion of where to prioritize future research in stunning methods for pigs to improve welfare for the 250 million pigs that are slaughtered in the EU every year. Research in alternatives to CO₂ for stunning pigs has been ongoing for decades. Electrical stunning was the first method used in large slaughterhouses to stun pigs, and it is still widely practiced worldwide. However, it has shortcomings regarding the animal welfare associated with isolation and restraint pre-stunning and meat quality due to severe muscle contractions. Stunning with alternative gasses (e.g., argon, nitrogen, and helium) can still ensure a groupwise stunning. However, there are concerns related to animal welfare including a longer time to loss of consciousness and a shorter duration of unconsciousness after stunning, relative to CO₂ stunning. Further concerns include poor meat quality due to pronounced excitation and the practicalities of sustainably procuring the gasses.

Currently, no viable alternative to groupwise CO₂ stunning has been established that to the same extent ensures good animal welfare, meat quality and high production efficiency. A focus on improving the concerns related to CO₂ stunning, rather than developing new stunning methods, will ensure that the animal welfare benefits of CO₂ stunning persist and that possible negative impacts on meat quality, production efficiency, as well as the need for large investments for slaughterhouses are avoided.

Research suggests the possibility of reducing the response to CO₂ by reducing stress before stunning. The hypothesis is pigs that experience a calm handling in a stress-reduced environment prior to stunning will also show a lesser reaction during stunning with CO₂. In 2022, DMRI will test this hypothesis. The objective of the project entitled “Stress free CO₂ stunning” is to investigate and document the effect of a stress-reduced handling before stunning on pigs’ initial reaction towards CO₂ and subsequently test new solutions towards an overall better welfare for pigs before and during CO₂ exposure.

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IMPROVED METHODS FOR STUNNING OF PIGS WITH FOAM; EFFECTS OF REPETITION AND SCENT ON PIG REACTION TO FOAM

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A method researched for stunning of pigs is nitrogen filled high expansion foam. In previous studies questions have arisen as to how aversive the pigs find the foam, and whether or not it is possible to reduce this aversiveness by, for example, adding a scent to the foam or by exposing the pigs to foam on repeated occasions. The aims of this study were to investigate if the pigs' behaviour were altered when scent was added to the foam, and if repeated exposure to non-scented air-filled foam would affect the pigs' behavioural reactions.

The study included 50 pigs (14-16 weeks of age), 30 in one group with vanilla scented air-filled foam, and 20 in the group that were exposed to a non-scented air-filled foam on three consecutive days. The first day of exposure to foam in the group of 20 pigs was also used as a control for the study with added scent.

When pigs were exposed to scented foam, the proportion of pigs exploring the foam was larger than in the group exposed to unscented foam. They also showed an increased activity. When the pigs were exposed to foam on three consecutive days there was an increased proportion of pigs from day one to three displaying vocalising behaviour, both in forms of grunts and screams/squeals. There was also a slight increase in the proportion of pigs showing escape attempts. Furthermore, increased exploration of the walls and decreased exploration of the floor was seen with time. The results indicate that it is possible to increase the pigs' interest in the foam by adding a scent to it, and there are no indications that a foam with added scent increases stress or anxiety. However, further research is needed to confirm that an increased interest in the foam is in fact correlated with lowering of stress or anxiety in the pig. The results also indicate that even though the pigs do not seem to get completely used to the foam when exposed to it on repeated days, their aversive behaviours do not increase either.

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THE CASE OF THE CULL SOW

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In commercial pig production, up to 50% of the sows are slaughtered each year. Pig production is characterized by increasing herd sizes, and fewer and larger slaughterhouses. Thus, transport distances to slaughterhouses are increasing. The movement and management of cull sows through the pre-slaughter logistic chain are not well described, and may differ considerably between countries. In this presentation, I discuss selected challenges to the welfare of Danish cull sows in the period from the farmer decides to cull them and until stunning.

One major challenge when sending sows to slaughter is the vulnerable clinical condition of some sows. Typical culling reasons are reproductive problems and reduced health. Hence, cull sows may be weak or prone to injuries, and thus less fit for transport than other categories of pigs. In the EU, the concept of fitness for transport is vaguely defined and difficult to handle for different stakeholders. Many cull sows show signs of clinical abnormality, which makes dealing with the concept of fitness for transport even more complicated.

Sows are typically mixed with unfamiliar conspecifics either on-farm when waiting to be picked up, or during loading. The natural response of pigs when mixed is to fight to establish a new hierarchy. Thus, throughout all stages of the pre-slaughter logistic chain, sows may fight, potentially leading to injuries and increasing the risk of heat stress, to which sows are prone – even when not fighting or being physically active. In their study of transport of sows for up to 8 hours under Danish conditions, Thodberg et al. (2019) found that the clinical condition of cull sows deteriorated on the way to the slaughterhouse. Among the risk factors were journey duration, temperature in the truck - often in interaction - and duration of stationary periods.

As exemplified above, the pre-slaughter logistic chain involves several challenges to the welfare of cull sows. Based on the OneWelfare concept, seeking to include human well-being and environmental concern in the solving of societal challenges involving animal welfare, the last part of the presentation will discuss possible interactions between the welfare of cull sows and the professionals – livestock drivers, farm staff, veterinarians - managing the animals during this period.

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FARM ANIMAL TRANSPORTATION REGULATIONS: TIME FOR A CHANGE?**Eugénie Duval¹, Benjamin Lecorps^{1,2} and Marina A.G. von Keyserlingk¹**¹Animal Welfare Program, Faculty of Land and Food Systems, University of British Columbia, Canada²Centre for Behavioural Biology, School of Veterinary Science, University of Bristol, UK
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Transportation of live animals has raised significant and growing concerns by many stakeholders along the supply chain, including the public. Transportation is without question a stressful experience for animals, but there are some well-identified factors that can exacerbate this experience. Animals are especially at risk for poor welfare when subjected to transport if their health is already compromised, if climatic conditions are extreme and if they are transported over long distances. During long journeys, animals are often being deprived of feed, water and rest for extended periods of time, which can lead to death. Given these challenges, regulations promoting better welfare during transport have been progressively adopted. However, disparities are high between countries and no systematic comparisons have been carried out. In addition, transport rules are under growing criticism with many calling for stricter enforcement and more protective regulations. Several countries have adopted new or recently revised existing animal transport regulations (e.g., Canada) while others are in the process of updating their regulations (e.g., the EU, the UK).

The aim of this study was to compare the current farm animal transportation regulations on 6 key animal welfare areas (i.e., duration of journey; fitness to transport; handling; weather conditions; densities; isolation) in 6 English-speaking jurisdictions (i.e., Australia, Canada, New-Zealand, the EU, the UK and the US).

Our first results show important variations between jurisdictions. Although some jurisdictions have regulated live farm animal transportation (e.g., the EU, Canada), others appear limited (e.g., the US). However, highly regulated transportation rules do not necessarily translate into higher animal welfare protection. Despite the recent revision of the transportation regulations in Canada, rules still lag behind some regions with older regulations (e.g., the EU). Variation between jurisdictions can be to some degree explained by differences in regulatory approaches. Whilst prescriptive regulations provide clear and precise requirements that must be met, outcome-based approaches provide more leeway for transporters and producers to achieve the required outcome. The absence of prescriptive requirements in some areas is sometimes problematic (e.g., no minimum/maximum temperatures set in Canada). The high variation in thresholds used by different countries also highlights that the regulations are mainly driven by geographical/economical needs rather than on directly addressing animal welfare issues. This variability may also reflect the absence of scientific knowledge on some key aspects (e.g., benefits of resting stops).

Overall, this study provides an up-to-date evaluation and comparison of the regulations to protect animals during transportation, highlighting similarities and differences between jurisdictions but also areas of improvement and remaining gaps.

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EUROPEAN LIVESTOCK DRIVERS' KNOWLEDGE ABOUT AND EXPERIENCE WITH ANIMAL WELFARE AND THE EU TRANSPORT REGULATION (1/2005)

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Background: Livestock drivers play an important role for animal welfare during transport, yet they have received very limited scientific attention. The aim of this project was to investigate European livestock drivers' knowledge about and experience with the EU Transport Regulation 1/2005, including the term "fitness for transport". Since the latter is vaguely described in the regulation a common understanding and interpretation of the term across the European Union (EU) is pivotal for maintaining animal welfare during transport.

Materials and methods: A convenience sample of livestock drivers were interviewed near the Danish-German border at the mandatory washing and disinfection facilities used as a precautionary measure against African Swine Fever for all livestock vehicles entering Denmark. Participation was voluntary and anonymous and based on a questionnaire, which was presented on a tablet and available in German, English, Romanian, Polish and Russian. The questionnaire included demographic questions, and questions related to knowledge about and experience with the EU Transport Regulation 1/2005, e.g. participants were shown pictures of different clinical conditions that could make an animal unfit for transport, e.g. ear bites or lameness and asked whether they would transport the animal or not. Lastly, the participants had the opportunity to add any comments they might have about animal transport.

Results: A total of 99 livestock drivers with 11 different nationalities were interviewed. The majority came from Poland (46%) and Germany (31%), and were employed in Poland (39%), Germany (29%) or Denmark (21%). All participants were male, mean age 39.5 years (range 23-64), drove between 2 and 48 journeys per month (mean 12) and had a mean experience with animal transport of 9.8 years (range 1-40). All had the mandatory Certificate of Competence for long distance transport within the EU. Fifty-one participants added comments covering frustration over inconsistent assessment of fitness between veterinarians and rules that the participants found made no sense in real practical life.

Conclusions and perspectives: Livestock drivers are a heterogeneous group of professionals in terms of knowledge and experience. In general, participants expressed a feeling of being in a very vulnerable position between farmers, hauliers, veterinary authorities and the public. Although, suspicious at first of being asked about their opinions and experiences, participants were generally happy that someone cared about their views on the animal transport industry. Hopefully, results from the present study can form a basis for further research into the role livestock drivers play in animal welfare. This present study mainly included transports from Denmark to either Germany or Eastern-European countries. Future studies should include livestock drivers from the south and west of Europe as well in order to gain a better understanding of livestock drivers across the whole EU.

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CONDITION OF BOB VEAL CALVES ON ARRIVAL AT AN ABATTOIR IN OHIO**Zachary England¹, Hannah Maggard¹, Andrew Fisher^{2,3}, Natalie Roadknight^{2,3} and Jessica Pempek¹**¹ Department of Animal Sciences, The Ohio State University, USA² Animal Welfare Science Centre, The University of Melbourne, Australia³ Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Australia*england.143@osu.edu*

Male or female calves not needed as replacements for the milking herd are considered “surplus” to dairy production. Surplus calves are typically marketed through live auctions within the first week of life in the United States, often leading to long transport times, irregular feeding schedules, fluctuating temperatures, and co-mingling with unfamiliar animals prior to arrival at the abattoir. Previous research has detected poor health outcomes in bob veal calves at arrival to abattoirs in other countries. However, the United States has limited federal regulations on calf age at transport, and very little is known about the condition of bob veal calves in this region of the world. The objective of this study was to assess the condition of bob veal calves at arrival to an abattoir in Ohio.

Between June and September 2021, data from 35 calves in 12 cohorts (n=420 calves) were collected within 2 h after calf arrival at the abattoir. Study personnel performed clinical health examinations to determine the prevalence of arthritis, broken ribs or tails, dehydration (using a skin tent test), depression, diarrhea, emaciation, fever, navel inflammation, and respiratory disease. Blood samples were also collected to measure serum total protein and blood glucose to assess failure of passive transfer of immunity (FPTI; using a cut-point of < 5.1 g/dL) and hypoglycemia (using a cut-point of < 3.2 mmol/L), respectively. Variables were dichotomized using clinically relevant cut-points, and descriptive statistics were used to determine the prevalence of poor health outcomes. Due to an unexpectedly large proportion of female calves (48%; 202/420), generalized linear mixed models were used to identify if calf sex was a risk factor for poor health outcomes.

Upon arrival to the abattoir, the most common physical health concern was dehydration (68.6%; 95% confidence interval: 59.1-78.0%), followed by emaciation (40.1; 29.1-51.1%), navel inflammation (25.7%; 21.2-30.2%), arthritis (17.4%; 10.5-24.3%), depression (17.1%; 12.6-21.7%), diarrhea (15.2%; 11.3-19.2%), signs of respiratory disease (10.5%; 7.72-13.8%), fever (9.3%; 4.6-14.0%), and broken ribs or tails (6.0; 2.4 to 9.5). Approximately one-fourth (23.4%; 18.6-28.2%) of calves had FPTI, and 8.9% (5.6-12.2%) were hypoglycemic. Calf sex was a risk factor for hypoglycemia (P = 0.003); male calves were more likely than female calves to have low blood glucose concentrations (odds ratio: 4.0; 95% confidence interval 1.6-10.1). These results indicate animal welfare concerns, such as FPTI, dehydration, and painful conditions (e.g., navel inflammation, arthritis) in bob veal calves at arrival to the abattoir. Evidence-based interventions to promote high-quality calf care throughout the calf production chain are needed.

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ELIMINATING DISCRETIONARY DEATHS IN THE CULL SOW TRANSPORT NETWORK**Ben Peyer¹ and Jennifer Brown^{2,3}**¹ Director Corporate Sustainability and Animal Welfare, Johnsonville LLC, USA² Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Canada³ Prairie Swine Centre, Saskatoon, Saskatchewan, Canada*bpeyer@johnsonville.com*

The well-being of cull sows during transport to slaughter is difficult to manage well, particularly in North America, where a) long travel times, b) a diffuse supply base consisting of hundreds of farms, and c) extreme weather in both summer and winter combine to generate dangerous conditions for sows during transport. The danger is particularly acute in the summer, which has historically seen transport deaths occur at nearly 3x the rate of non-summer periods.

Management of cull sow transport also suffers from a stark imbalance between the low cost to the enterprise of transport deaths – just over two sows per thousand in the high period – and the high cost to the animals in terms of suffering. We target transport deaths because improvements in death rates delivers better subjective and objective well-being for every associated animal.

An analysis of outcomes on 155,000 animal shipments between the years 2010 and 2021 suggests that 35% of transport deaths – either dead on arrival (DOA) or euthanized on arrival (EOA, collectively E/DOA) – can be attributed to choices made prior to or during transport, independent of the structural difficulties listed above. We label these transport deaths “discretionary” because the deaths (along with attendant suffering for all animals, including those that survive) are the product of individual choice. Our objective was to design and build a process to eliminate discretionary transport deaths for Johnsonville, which slaughters 28% of US and Canadian cull sows per year in three abattoirs.

The guiding principle for the new process is:

The act of loading animals onto a truck bound for Johnsonville constitutes a commitment to provide humane care to those animals. A viable plan for providing humane care is a prerequisite for allowing any animal to begin transport to a Johnsonville facility.

Implementation of this principle consists of four major parts:

1. Clear definitions of what behaviors and conditions are consistent with having, and having followed, a “viable plan for providing humane care”
2. Bespoke planning tools made available to all stakeholders to schedule shipments within windows that allow for humane transport
3. Root cause investigations for any load with multiple transport deaths, with corrective actions mandated
4. Regular internal and external communication around key performance metrics, with volume and financial penalties imposed for repeated violations of the principles for humane transport

Since the inception of this process in 2019, summer transport deaths have decreased by 20% relative to previous levels given weather conditions in supply regions. While multiple confounding factors prevent us from claiming a definite causal relationship between this work and improved outcomes, the framework seems to focus attention on critical decision points, and warrants both continued development and broader adoption.

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THE POST-EGG PHASE: WELFARE DURING PRE-SLAUGHTER

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The welfare of spent laying hens in the pre-slaughter phase is a complex issue. Due to the low economic value and the low turn-over of those hens, the opportunities to invest in better welfare are limited. The pre-slaughter phase includes catching, transporting, waiting at the lairage and stunning of the hens. In this phase, the hens undergo several manipulations which may cause stress and pain. In this retrospective study, several possible risk factors and impacts were observed.

Slaughterhouse data from a Belgian slaughterhouse from 8534 laying hen loadings between 2015 and 2020 were analysed. Several variables, like housing, hybrid, season, plumage condition, transport distance, crate load and lairage time, were analysed and correlated with the percentage of dead delivered hens (Dead On Arrival, DOA) and/or catching damage (leg and wing fractures). All animals were stunned by electrical stunning.

Catching damage to the legs was more common in brown versus white hens in all housing systems ($P < 0.001$), while for wing damage this was only seen in enriched cages ($P = 0.017$). Concerning the housing system, more catching damage was seen in enriched cages compared to non-cage systems ($P < 0.001$). Brown hens showed higher DOA rate than white hens ($P = 0.011$). Increased percentage of DOA was related to high catching damage ($P < 0.001$), and long transport (> 300 km, $P < 0.001$) and lairage time ($P < 0.001$).

Transport during winter was also contributing to an increased DOA rate ($P < 0.001$), and additionally, low crate density ($P = 0.005$) and poor plumage condition ($P < 0.001$) resulted in extra mortality. The main finding of this retrospective study is that spent laying hens are exposed to cold stress during transport, and an extended lairage time have an increased risk of mortality. Cold stress can be associated with the winter period in a mild maritime climate and a poor plumage condition. Moreover, high catching damage and a long pre-slaughter phase have a reinforcing effect on mortality.

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THE ON-FARM SLAUGHTER PROCEDURE LEADS TO INCREASED ANIMAL WELFARE IN PIGS

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Animal loading, unloading, and transport before slaughtering are important critical points through the whole process of pigs production. Several studies showed that the effect of transport on animal welfare depends on a combination of stressors. It's possible to significantly decrease the suffering and stress level of animals before slaughter by eliminating the transportation phase (from farm to abattoir) by killing animals directly on the farm. Nowadays, in Europe on-farm slaughter is not allowed as a routine method, but it is used only for emergencies; thus, more studies to verify its effectiveness as a routine method are needed.

The trial aimed to compare the effect of a traditional slaughter procedure (T) versus an on-farm slaughtering system (F) on pigs, focusing on welfare, meat safety, and meat quality parameters. The research was carried out on 32 pigs of the Cinta Senese breed reared according to organic European rules in Tenuta di Paganico farm. Pigs were equally and randomly allotted to two groups according to the above-mentioned slaughter procedures. Animals were slaughtered about 130 kg of live weight at about 13 months. Group T was transported alive to the abattoir (about 20 km away from the farm) 2 hours before slaughtering. Group F was stunned and bled directly on-farm, then carcasses were transported to the slaughterhouse by a refrigerated trailer: that procedure followed the Local Veterinary Health Unit guidelines. The animal's welfare was assessed by blood sampling at exsanguination: creatinine kinase, lactate dehydrogenase, total protein, albumin, glucose, and serum cortisol were determined.

Preliminary results on 22 pigs seem to indicate no significant differences between T and F for any parameter evaluated, except for serum cortisol (13.41 ± 1.61 ng/mL vs 19.52 ± 1.49 ng/mL, $P = 0.01$, in F and T respectively). This data suggests that the F procedure was effective in reducing animals' stress. Moreover, we also considered microbial meat contamination, which thus can affect negatively meat safety, especially in on-farm slaughter systems. Aerobic Mesophilic Colony and Enterobacteriaceae Counts and, *Staphylococcus aureus*, *Salmonella*, and *Listeria* presence were detected (Zoo-prophylactic Institute of Lazio and Tuscany, (Pisa - Italy). Our preliminary results seem to demonstrate that the kind of slaughter procedure does not negatively affect meat safety; in fact, we found no differences between the slaughtering procedure in all of the aforementioned parameters. Finally, meat technological and physic characteristics were analyzed: pH (at 48 hours after slaughter), colour, and water holding capacity. Our preliminary results showed no significant difference in all parameters. In conclusion, our trial seems to indicate that the on-farm slaughtering procedure is able in limiting the animals' stress without getting worse the meat safety and quality.

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ABATTOIR INSPECTION AS EARLY WARNING SYSTEM TO IMPROVE PIG WELFARE AT FARM LEVEL

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In the last decade, scientific results emphasised the importance of the meat inspection for animal welfare surveillance by providing early warning and feedback to the farmers, but the contrasting results suggest further investigation on the specific indicators related to herd management.

The present study aimed to evaluate whether data collected at the abattoir at post mortem inspection can be used as an early warning of welfare issues at farm level.

For 6 months, a total of 906 carcasses, equal to 10% of each batch from 12 intensive commercial farms, slaughtered in 3 different plants in Northern Italy, were included in this study.

Relevant animal welfare indicators were selected based on their validity and feasible evaluation during the slaughtering process; then a protocol for visual-only meat inspection was created. Three animal welfare officers were trained in applying the protocol with an online training day. The whole carcass was examined for lesions detectable at the external examination (severe chronic traumatic wounds on the skin, tail lesions, ear lesions, bursitis and deformity of bones of the limbs), and for pathological conditions of internal organs (pericarditis, hepatic milk spots, pleurisy and enzootic pneumonia).

For gathering retrospective information about welfare status of farms, early warning thresholds were set according to Dalmau et al. (2016), Kongsted and Sorensen (2017) and Bottacini et al. (2018). In one farm severe chronic traumatic wounds exceeded the limit of 5% (7.1%). For tail-docked pigs, 6 farms overstepped the threshold of 1% of animals affected by tail lesions (min: 3.0% - max: 9.8%) and for ear lesions one farm exceeded the cut-off point set on 10% (12.5%). Relating to bursitis and bone deformity, 4 farms for each lesions exceeded the thresholds of 3% (min: 3.1% - max: 10.0%) and 0.5% (min: 10.3% - max: 17.1%) respectively. For pericarditis, 7 farms overpassed the limit of 3% (min: 7.15% - max: 12.5%) and even 6 farms exceed the threshold of 10% of pigs with white liver spots (min: 12.1% - max: 25.5%). Regarding pleurisy, the threshold set on 15% was exceeded by 2 farms (18.4% and 25.0%), while 7 farms exceed the threshold of 6.5% of pigs with enzootic pneumonia (min: 7.9% - max: 54.1%).

In conclusion, only one farm reported no early warnings, while three farms showed a non-conformity of over 50% of the selected indicators. The findings of this study suggest that these indicators may be used as feedback for farmers to enhance the welfare of animals, by reducing the incidence of these lesions and pathologies. Further research is suggested to investigate the correlation of these indicators with herd management and improving a more standardized animal welfare officer training, including an interobserver reliability test to avoid any subjective judgement.

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