Assessing pig welfare at stunning in Northern Italy commercial abattoirs using electrical method

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SUMMARY
According to Council Regulation 1099/2009 regular checks at stunning are compulsory to ensure that the animals do not present any signs of consciousness or sensibility in the period between the end of the stunning process and death. So far there are no data available on the prevalence of correctly electrically stunned pigs in Italy and on the signs more effective to use in practice to evaluate poorly stunned animals or return of consciousness. The aim of this study was to evaluate the prevalence of correctly stunned pigs by electrical stun in Italian commercial abattoirs through the clinical analysis of signs of consciousness. Four commercial abattoirs using three different electric stunning systems were studied to assess the efficiency of stunning. The abattoirs A and C used head-only manual stunning with an intensity ≥ 1.3A; the abattoir D used head-only manual stunning with an intensity 0.4 - 2A and the abattoir B used head-heart automatic stunning with an intensity ≥ 2.5A and ≥ 1A for the head and the chest respectively. A total of 1620 heavy pigs were evaluated from stunning to complete bleeding to evaluate the presence of signs of consciousness (animal alert, presence of rhythmic breathing, head uplift, pain reaction) and other signs (vocalizations, tongue movements, etc.). At the end of the observation the evaluator expressed a judgment concerning the state of consciousness for each pig conscious: presence of rhythmic breathing and/or pain reaction and/or righting reflex; doubtful: not clear presence of rhythmic breathing or pain reaction or righting reflex. A statistically significant difference was observed in the distribution of the state of consciousness between the different abattoirs (p=0.01) and between the three different stunning systems (p=0.04). Abattoir B resulted to be more efficient (0% conscious; 0.25% doubtful) in stunning, compared to the others: abattoir A (0.5% conscious; 0.7% doubtful); C (2% conscious; 0.5% doubtful); D (1.7% conscious; 0.7% doubtful). Pain reaction, rhythmic respiration and head uplift could be used as practical key parameters for a regular evaluation of stunning, however future investigations are needed to better clarify their effectiveness taking into consideration the site of application of tongs and the current applied to each animal. The importance of tongue movements in apparently unconscious animals should be also investigated with more attention. No correlation was found between the state of consciousness and any of the anamnestic variables considered (signs of recent fighting; weight higher or lower than the range; signs of stress).

KEY WORDS
Pig, electrical stunning, welfare, slaughter, unconsciousness.

INTRODUCTION
In Italy more than 13.7 million pigs are slaughter every year whereof about 11.9 million are finishing pigs for the production of cured ham. Maintaining high standards of animal welfare during transportation, lairage and slaughter requires appropriate equipment and supervision of employees. During slaughter, the animals should be unconscious in order to avoid inflicting undue pain and stress during the procedure; thus they should not be allowed to recover consciousness post-stunning. Electrical stunning is the stunning method commonly used in all major commercial abattoirs. Electrical stunning achieves an immediate stun by inducing a tonic/clonic epileptic fit during which the animal is unconscious. Epilepsy will be induced provided sufficient current passes through the brain. In the head-only stunning electrodes must be placed to span the brain, enabling the current to pass through it. When electrodes are correctly applied, a current of 406mA applied for at least 3s is effective with sufficient duration of unconsciousness. When electrodes are placed in the least optimal position a current of 1.3 A is needed. In the head-to-chest stunning a further electrode is applied to the chest of the pig and a cardiac arrest cycle is performed, with major animal welfare advantages in terms of reduction of the incidence of signs of return to sensibility, without significant effects on meat quality.

As previously described, following a successful electrical head-only stun, pigs will show immediate collapse, tonic seizure and apnoea followed by clonic seizure and gradual relaxation of the body. The report edited by Efsa indicated also that absence of tonic or tonic-clonic seizures, presence of rhythmic breathing, focused eye movements, constricted pupils, vocalization during stunning and return of the head righting reflex are indicators of inadequate stunning. In the...
head-to-body stunning (one cycle method) following an effective electrical stunning pigs show immediate collapse followed by a tonic phase, a clonic phase weak or even absent, dilated pupils and relaxed carcass with gagging and corneal reflex maybe present briefly. Signs of inadequate stun are the same of head-only stun but also the presence of convulsion during bleeding.

According to Council Regulation 1099/2009 business operators shall ensure that persons responsible for stunning carry out regular checks to ensure that the animals do not present any signs of consciousness or sensibility in the period between the end of the stunning process and death. Those checks shall be carried out on a sufficiently representative sample of animals and their frequency shall be established taking into account the outcome of previous checks and any factors which may affect the efficiency of the stunning process.

So far there are no data available on the prevalence of correctly electrically stunned pigs in Italy and on the signs more effective to use in practice to evaluate poorly stunned animals or return of consciousness.

The aim of this study was to evaluate the prevalence of correctly stunned pigs in Italy and on the signs more effective to use in practice to evaluate poorly stunned animals or return of consciousness.

The aim of this study was to evaluate the prevalence of correctly stunned pigs by electrical stun in Italian commercial abattoirs through the clinical analysis of signs of consciousness.

**MATERIALS AND METHODS**

The survey was carried out in four commercial pig abattoirs in Northern Italy that used three different electrical stunning systems. The abattoirs A and C used head-only manual stunning with an intensity $\geq 1.3A$; the abattoir D used head-only manual stunning with an intensity $0.4 - 2A$ and the abattoir B used head-heart automatic stunning with an intensity $\geq 2.5A$ and $\geq 1A$ for the head and the chest respectively. More details on the abattoirs and stunning characteristics are reported in Table 1.

The typical Italian heavy pig (160 kg ± 16 kg) was slaughtered in all the premises. In all the four slaughterhouses the pigs after being stunned, fell on a horizontal conveyor where they were bled by severing major blood vessels in the chest (thoracic stick) whilst the animal was prone. They stayed on the platform for additional 15-20 seconds before being shackled and hoisted.

<table>
<thead>
<tr>
<th>Abattoir</th>
<th>Speed (pigs/hour)</th>
<th>Tongs position</th>
<th>Type of stunning</th>
<th>Ampere applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>360</td>
<td>Below the base of the ears</td>
<td>Head-only manual</td>
<td>$\geq 1.3$</td>
</tr>
<tr>
<td>B</td>
<td>400</td>
<td>Below the base of the ears and at chest</td>
<td>Head-heart automatic</td>
<td>$\geq 2.5$ (head) / $\geq 1$ (heart)</td>
</tr>
<tr>
<td>C</td>
<td>260</td>
<td>Below the base of the ears</td>
<td>Head-only manual</td>
<td>$\geq 1.3$</td>
</tr>
<tr>
<td>D</td>
<td>375</td>
<td>Between the eyes and the base of the ears</td>
<td>Head-only manual</td>
<td>$0.4 - 2A$</td>
</tr>
</tbody>
</table>

**Statistical calculation of sample size**

As the prevalence of conscious animals was not known, the sample size of the observations per slaughter was calculated as follows:

- the population size for each abattoir was calculated as infinite;
- as the prevalence of conscious pigs was not known, the expected frequency was set at 50%;
- the confidence level was set at 95%;
- the maximum tolerable error in estimated prevalence was fixed at 5%.

The sample size calculated with these parameters was 384 animals as minimum.

**Assessment of insensibility**

Each pig was individually examined by three observers from the end of application of tongs to complete bleeding (death) for the presence of signs of a correct stunning and return to sensibility.

These signs were examined to assess the consciousness of animals:

- Animal Alert (AA): animal awake and aware of its surroundings;
- Head Uplift (HU): raising of the head or arching of back in animal’s attempt to right itself or recover normal body position;
- Pain Reaction (PR): any response to a painful stimulus such as a severe prick on the nose with a sharp instrument (Nose Prick);
- Rhythmic Respiration (RR): rhythmic air inhalation seen in the form of regular expansion/contraction of chest or flank area or feeling rhythmic air exhalations on the back of the hand.

These additional signs were also monitored:

- Blinking (B): the animal blinks its eye on its own without stimulation;
- Body Shivering (BS): the animal shivers;
- Clonic Convulsion (CC): excessive clonic convolution;
- Corneal Reflex (CR): the animal blinks in response to soft tip of the cornea;
- Chewing (CW): the animal opens and closes the mouth;
- Irregular Gasping (IR): occasional opening of the mouth with the sound or appearance of short gasps of air intake at sporadic intervals;
- Nystagmus (N): rapid movements (twitching) of the eyeball from side-to-side;
- Eyelid Reflex (ER): the animal blinks in response to soft tip of the eyelid or eyelashes;
- Snout Shivering (SS): the snout of the subject makes involuntary movements in rapid succession;
- Tongue Movements (TM): the subject shows limited movements of the tongue;
- Vocalization (V): the animal groans but doesn’t squeal.

At the end of the observation the evaluator expressed a judgment concerning the state of consciousness for each pig:

- conscious: presence of rhythmic breathing and/or pain reaction and/or righting reflex and/or the animal appeared alert;
- unconscious: presence of loss of posture, tonic phase, and clonic phase (not for head-heart; automatic stunning); absence of rhythmic breathing, pain reaction, righting reflex;
– doubtful: not clear presence of rhythmic breathing or pain reaction or righting reflex.
Moreover, supplementary information were recorded about some anamnestic variables, i.e. signs of recent fighting, weight higher or lower than the range (144-176 kg) or signs of stress (redness of the skin) for each pig.

Statistical analysis
The prevalence of unconscious animal and the exact confidence intervals were calculated for each slaughter (Clopper-Pearson interval). The state of consciousness was evaluated against abattoir, stunning system and presence/absence of anamnestic variables by Fisher’s exact test.
All the analyses were performed using R 2.15.2. software.12

RESULTS AND DISCUSSION
Swine are very sensitive to stress and previous studies documented well the metabolic and physiological effects triggered by stressful stimuli like long journeys, fasting and all the handling procedures. In electric stunning not only welfare but also carcass quality can be negatively affected by all the ante-mortem procedures as well as by a poor use of this technique. In this study the observations in the pre-stunning phases revealed that tongs were correctly positioned as described by Anil and McKinstry in 1998 in all the pigs observed. None of the animal screamed at current administration and no burning of the skin, sign of poor electrode maintenance and/or contact with the head, were recorded.

Chest sticking was correctly performed on all the animals at first attempt between 4 and 8 s from the end of stunning.

In Table 2 the number of animal observed and the prevalence of animal unconscious, conscious and doubtful are reported for each abattoir. Prevalence of unconscious animals and 95% confidence intervals (Clopper-Pearson interval) for the different abattoirs are reported in Graphic 1. It can be observed that abattoir B has an higher prevalence of unconscious animals compared to the others.
A statistically significant difference was observed in the distribution of the state of consciousness between the different abattoirs (Fisher’s exact test, p=0.01) and between the different stunning systems (Fisher’s exact test, p=0.04) with slaughter B (head-heart automatic stunning method) being more efficient. This is not surprising as it was expected to find mild differences between different slaughterhouses, even if we wrongly assumed to find much more doubtful and conscious animals in the abattoir using a current not constantly ≥ 1.3 but between 0.4 and 2A (D).
Maybe this happened because in this abattoir tongs were basically always positioned between the eyes and the base of the ears, the ideal position to span the brain while in abattoir A and C the tongs were positioned a little backward from this ideal position. However the position of the tongs was not individually recorded for each animal and then it was not possible to establish a correlation with this parameter. Not surprisingly, head-to-chest stunned

<table>
<thead>
<tr>
<th>Slaughter</th>
<th>Animal observed</th>
<th>Unconscious</th>
<th>Conscious</th>
<th>Doubtful</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>IC95%</td>
<td>n</td>
</tr>
<tr>
<td>A</td>
<td>391</td>
<td>383</td>
<td>98.0</td>
<td>96.0 - 99.1</td>
</tr>
<tr>
<td>B</td>
<td>400</td>
<td>399</td>
<td>99.8</td>
<td>98.6 - 1.00</td>
</tr>
<tr>
<td>C</td>
<td>407</td>
<td>397</td>
<td>97.5</td>
<td>95.5 - 98.8</td>
</tr>
<tr>
<td>D</td>
<td>422</td>
<td>412</td>
<td>97.6</td>
<td>96.0 - 99.0</td>
</tr>
<tr>
<td>Total</td>
<td>1620</td>
<td>1591</td>
<td>98.2</td>
<td>97.4 - 98.8</td>
</tr>
</tbody>
</table>

Graphic 1
Prevalence of unconscious animals and Clopper-Pearson confidence intervals for the different abattoirs.
The association between the state of consciousness was not significant (Fisher's test, p>0.05) for any of the anamnestic variables considered (signs of recent fighting; weight higher or lower than the range; signs of stress).

The detailed signs observed for conscious and doubtful animals are reported in Table 3 and 4 respectively.

In case of doubtful animals, the observer was not able to state for most of the animals if they were effectively showing RR or PR. For some other animals (animal 1 and 4 in slaughter 4) TM not clearly coordinated or V (animal 2 in slaughter 3) were observed. Some selected signs recorded in unconscious animals (nr. 1591) are reported in Table 5.

The prevalence of most of the different signs differ between abattoirs (Fisher’s exact test, p<0.01 for blinking, gasping, vocalization, chewing). It is interesting to note that in abattoir 2 no chewing or tongue movements were observed in unconscious animals while their prevalence was low in the other slaughterhouses. On the contrary, in conscious animals the prevalence of animals showing tongue movements was high (35%) compared to the prevalence of other signs such as corneal reflex (12%), eyelid reflex (12%), or vocalization (18%). This observation could led to suspect that tongue movements could be considered more carefully as a possible sign of regaining consciousness.

**CONCLUSIONS**

From an animal welfare point of view, the suitability of a stunning method is dominated by its capacity to render in-
Pain reaction, rhythmic respiration and head uplift could be used as practical key parameters for a regular evaluation of stunning, however future investigations are needed to better clarify their effectiveness taking into consideration the site of application of tongs and the current applied to each animal. The importance of tongue movements in apparently unconscious animals should be also investigated with more attention.

Table 5 - Distribution of some selected signs in unconscious pigs.

<table>
<thead>
<tr>
<th>Abattoir</th>
<th>n</th>
<th>Blinking %</th>
<th>Gasping %</th>
<th>Vocalization %</th>
<th>Chewing %</th>
<th>Tongue Movements %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>383</td>
<td>9.66</td>
<td>25.59</td>
<td>0.26</td>
<td>2.87</td>
<td>0.26</td>
</tr>
<tr>
<td>2</td>
<td>399</td>
<td>0.25</td>
<td>1.25</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>397</td>
<td>2.27</td>
<td>17.63</td>
<td>2.27</td>
<td>-</td>
<td>1.01</td>
</tr>
<tr>
<td>4</td>
<td>412</td>
<td>11.65</td>
<td>16.99</td>
<td>6.07</td>
<td>0.73</td>
<td>1.21</td>
</tr>
</tbody>
</table>

References