AN INVESTIGATIVE STUDY OF 2 PIG ABATTOIRS IN SWEDEN WITH REGARD TO C02 CONCENTRATION, C02 EXPOSURE TIME, STUN GROUP SIZE, STUN TO STICK INTERVAL, AND STUN EFFECT.

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Introduction
Preslaughter stunning has the prime aim to ensure the animal is insensible to exsanguination and post slaughter procedures. The stun itself should be painless, close to instantaneous in its effect, and should provide a duration of insensibility which ensures that death from subsequent slaughter intervenes before recovery of sensibility (Cook et al., 1999).

The Swedish Board of Agriculture have set down regulations for CO2 stunning of pigs in abattoirs, and stipulate that the time interval between the last CO2 exposure and exsanguination (stun to stick interval) should be within 60 seconds. These regulations are based on EU guidelines made in 1991 for CO2 stunning in abattoirs. In recent years group CO2 stunning procedures have been implemented in Sweden based on Danish designs. The concept is comprised of three main elements:

- an area where groups of approximately 20 pigs are divided into smaller groups
- automatic transfer of these smaller groups to and through the stunning equipment utilizing their flock behaviour
- a system for presenting the stunned pigs for shackling and sticking.

After the end of CO2 exposure under some conditions pigs can begin to regain consciousness and can recover completely (Forslid, 1987; Holst, 1998). Also, due to biological variations, some pigs will never recover from the stunning conditions while others will be reversibly stunned and show indications of regaining consciousness within a given time after the end of the CO2 exposure. Therefore to ensure good animal welfare during post stun handling of pigs, CO2 stunning should always induce unconsciousness of a sufficient duration which should include not only the stun stun-stick interval but also the time taken for the animal to become insensible due to debleeding (Holst, 1999).

According to EU regulations (Council Directive 93/119/EC) pigs must be exposed to CO2 for long enough to ensure they remain unconscious until they have been killed. Furthermore, bleeding (sticking) must be started as soon as possible after stunning, and in any event carried out before the animal regains consciousness.

To ensure good stunning practice under CO2 stunning i.e. no pigs regain consciousness during post-stun handling and bleeding, the safe depth of anaesthesia at the time of sticking can be evaluated by the following criteria:

No pigs shall show deep or regular respiration except for irregular abdominal gasping
No pigs shall show signs of excitement or kicking apart from for slow movements of legs
No pigs shall have spontaneous blinking of the eye
Maximum of 5% pigs can have corneal reflex

Corneal reflex is a good criterion for assessing consciousness because when there is no corneal reflex, it indicates deep anaesthesia or death of the animal (Holst, 1999).

Aim
This study aimed to investigate in 2 different CO2 group-stunning abattoirs (A and B):
Actual group size in the stun boxes in abattoirs A and B
Actual stun to stick time intervals for each pig in the stun groups
Stun effect when stun boxes are in CO2 concentrations not less than 70% in the first stop and not less than 90% in the bottom stop at exposure duration of 210 seconds in abattoir A and 150 seconds in abattoir B.

Material and Method
Observational studies and data recordings were made at 2 abattoirs A and B for stun group size, stun to stick interval and stun effect. These parameters were recorded for 502 stun groups (3444 pigs) over a 2 day period for abattoir A, and 553 stun groups (2325 pigs) over a 3 day period for abattoir B. The results for each abattoir were analysed separately.

The stun effect was assessed for every stun group during the study period starting after the 2nd pig of each group. This was done by a person trained and experienced in assessing pigs for consciousness. Any information indicating poor stunning was recorded. When there were stops in the slaughter line and the last pigs in a stun group had extended stun to stick intervals, extra care was taken to check for signs on these pigs for regaining consciousness. The same person conducted all consciousness assessments throughout the study.

Results
Abattoir A: In abattoir A the stun group sizes varied between 3 and 10 pigs, with majority between 6 and 8. The most common stun group size however was 7. The rotation times for the boxes to pass through the stunning system varied. Thus the CO2 gas exposure times for each group of pigs in the stunning system varied. The CO2 exposure times for stun groups were estimated from 46 box rotation times and making a calculation to estimate the CO2 gas exposure times when pigs were in CO2 gas concentrations above 70%. The average CO2 exposure was estimated at 282 seconds. There were no pigs out of a total of 3444 that showed signs of regaining consciousness.

Abattoir B: In abattoir – B the stun group sizes varied between 2 and 6 pigs with the majority between 4 and 5. The most common stun group size however was 4. 79% of all pigs in the study were stuck after 60 seconds, i.e. 21% with a stun to stick interval within 60 seconds. The fastest stun to stick interval was 41 seconds and the longest 145 seconds. The CO2 exposure times for stun groups were estimated from 28 box rotation times and making a calculation to estimate the CO2 gas exposure times when pigs were in CO2 gas concentrations above 70%. The average CO2 exposure was estimated at 238 seconds. There was one pig out of a total of 2325 pigs that showed spontaneous blinking of the eye and corneal reflex.
Discussion
This study investigated stunning procedures in 2 different abattoirs with similar CO₂ pig group stunning practices. In total, 5769 pigs and 1055 stun groups were observed for the purposes of assessing animal welfare after stunning. The stunning procedure was observed to assess how good the stunning practice was overall. The stunning systems varied in that abattoir A operated with 7 boxes rotating through a CO₂ chamber 10 meters deep. Abattoir B operated with 6 stunning boxes rotating through a CO₂ chamber 9 meters deep. The maximum slaughter capacity for abattoir A is 720 pigs per hour, and in abattoir B, the slaughter line has the capacity for 300 pigs per hour.

In both abattoirs the CO₂ gas concentrations exceeded the minimum recommended by the manufacturer of the system i.e. 70% at the upper level, and 90% at the lower level. In both abattoirs the CO₂ gas concentrations exceeded the minimum recommended by the manufacturer of the system (EU legislation requires a minimum of 70%). In abattoir A the average CO₂ exposure time was 286 seconds, and the minimum time 218 seconds. In abattoir B the average CO₂ exposure time was 238 seconds, and the minimum time was 193 seconds. There is variation in stun exposure times and box rotation times due to factors that occur during the division of the immediate preslaughter groups.

The stun to stick intervals for each pig in a stun group varied by 20 to 30 seconds for both abattoirs. Stun to stick intervals varied due to many factors other than group size. Stops occurring in the systems caused most of the delays in sticking time. In abattoir A stops occurred due to the derailment of shackles holding pigs as they were conveyed around a hook bend just before being stuck. Occasionally shackled pigs were derailed completely and fell off the line onto the abattoir floor before sticking. There were also quite a few stops just after sticking where shackled pigs passed through a narrow gap between 2 walls. However most causes of the stops could not be seen, as they occurred far down the slaughter line past sticking.

The stun effect in this study was considered to be 100% effective in abattoir A and B. One pig (abattoir B) of a total of 5769 pigs (0.043%) stunned showed corneal reflex and spontaneous blinking of the eye. It was the 3rd pig in a group of 4. The stun to stick interval was 80 seconds, which was the average interval for every 3rd pig of a group for this abattoir and it showed no other symptoms.

Conclusions
The results of this study have shown that the minimum to maximum stun to stick intervals are 46 to 160 seconds for abattoir A, and 41 to 129 seconds for abattoir B and that these intervals allow for an acceptable stunning. Therefore the recommended stun to stick interval can be reviewed.

References