Euthanasia of Piglets <7kg using a Dutch Mini-Noff Unit

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Introduction:

There is a limited amount of information on gaseous euthanasia of livestock. This is, of course, a sensitive issue, both in research and public perception of euthanasia options. There have been studies on piglets using different gases, notably carbon dioxide, argon and nitrogen. Nitrogen and carbon dioxide were used in an unpublished study at the University of Wagenigen. Nitrogen is considered a narcotic gas. Nitrogen is also lethal when inhaled in its purest form. Despite the noxious disadvantage of carbon dioxide as a stand-alone euthanizing gas, it continues to be used because of availability and cost. Additionally, there is a commercial unit that has been designed for euthanasia of piglets using carbon dioxide in a controlled manner. Although nitrogen is slightly lighter than air, it can be used as a euthanizing agent when the device it is used in is closed and impermeable to leakage.

Objectives:

1. To evaluate the use of nitrogen only in the miniNOFF system for euthanasia of piglets <3.5 kg. This project is comparing the efficacy (time to no movement) of this unit with the earlier study using a prototype and nitrogen gas. The results for time to no movement of the Euthanex study will be compared as well.

2. To compare the cost of euthanasia using nitrogen in the miniNOFF system with the cost of euthanasia using the Euthanex device.

On-farm euthanasia of piglets is conducted for piglets which are compromised by light birthweight and inability to compete for milk, and for those with disabilities such as lameness, navel infections, injury or illness. There are several options available to producers to euthanize piglets, as outlined in the Codes of Practice for the Care and Handling of Pigs. These include blunt trauma, non-captive penetrating bolt, CO2 euthanasia, and anaesthetic overdose. Anesthetic overdose may only be administered by a veterinarian.

A nitrogen and carbon dioxide mixture has been described for use in euthanasia of swine. This mixture (70% nitrogen and 30% carbon dioxide) demonstrated lateral recumbency in piglets between 64 and 94 seconds; time to no movement was 282 seconds. This study recommended gas supply and control should be conducted to result in a fast build-up and maintenance of an atmosphere containing less than 1% oxygen.[1]

Nitrogen gas stunning has been reported to be effective; however, the gas mixture becomes unstable as nitrogen is less dense than air and it is difficult to maintain concentrations greater than 94% in a stunning system.[2] A previous Ecovet study (2017) used a plexiglass box with a drop door for introduction of piglets. Piglets were placed in the unit and nitrogen introduced over 5 – 7 minutes. Time to no movement averaged 1.92 minutes to 6.42 minutes. Smaller and more severely compromised piglets succumbed more rapidly to nitrogen gas euthanasia than less compromised piglets.

A mini-NOFF unit is a N2/C02 unit designed and utilized in the Netherlands for small scale euthanasia of piglets. It consists of 2 metal cones with a plenum; there is an electronic unit with a start/stop button; inside the unit there is a timer that may be adjusted. This unit was used in this trial to evaluate its efficacy comparing N2/C02 or pure nitrogen gas.

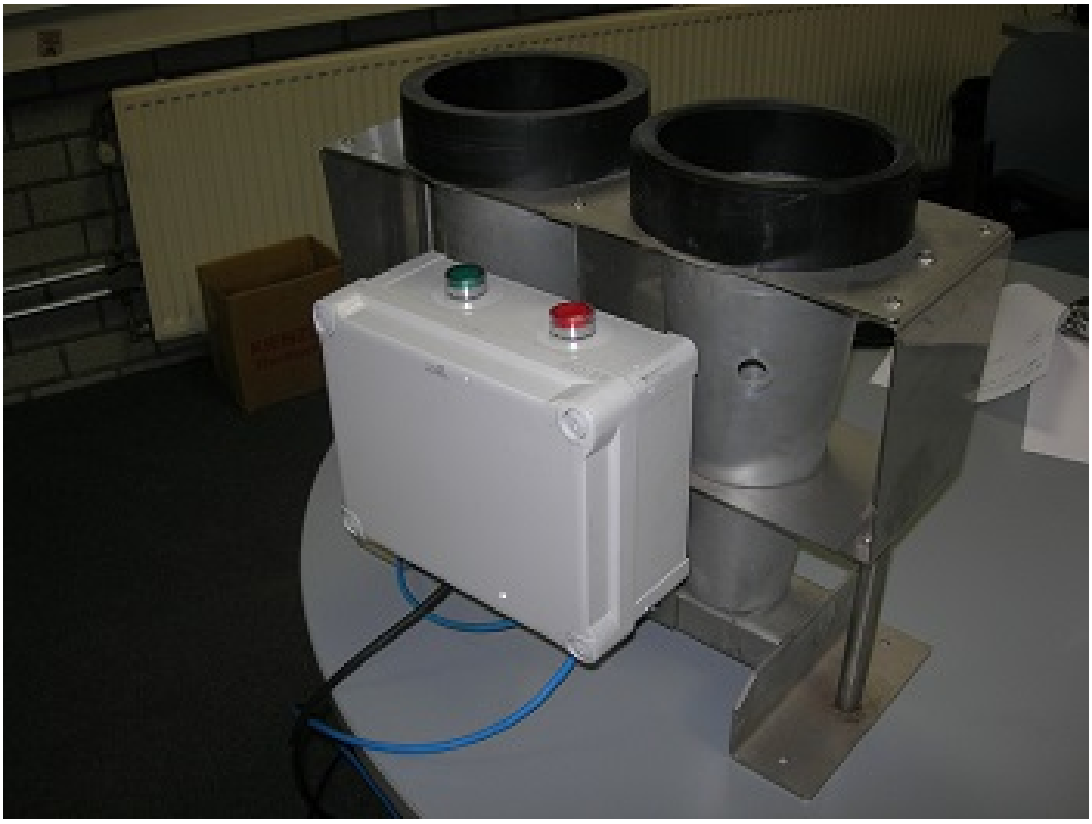

Photo of miniNOFF

Methodology

A miniNOFF unit was acquired from TCC in the Netherlands. The unit was adapted to North American electrical standards.

Two types of gas were used in this study – a 70/30 N_2/CO_2 gas mixture and a pure nitrogen gas. Gases were purchased at a farm supply store; the gases originate from Praxair.

Compromised and/or moribund piglets were sourced from a 1600 sow barn. Piglets were sedated with 0.2 ml Stresnil (Vetoquinol) prior to euthanasia. Animals were observed individually during the process.

N_2/CO_2 was run at 1 litre/minute, and a prefill of one minute was done prior to placement of piglets. Nitrogen was run at varying rates, from 1.6 litre/minute to 8 litre/minute, with a prefill of one minute prior to placement of piglets. A total of 33 piglets were euthanized using this combination.

A total of 28 piglets were euthanized using N_2 gas.

When small piglets (<750 gm) were placed in the unit, it was noted that the head frequently was flexed. There was concern that this would impair respiration of the piglet, and a small modification was made to the unit so that the hind legs of the piglet were held on the lip of the cone.

A plastic cap was devised to place over the piglet in this position when using nitrogen only, in order that nitrogen gas could be retained in the cone. Two openings were created in the cap so that the hind legs could pass through and be held by the observer.

Plastic cap

Time to no movement was measured in all piglets. Piglets that had not succumbed by 7 minutes were euthanized with a barbiturate injection. Corneal reflex, observation of lack of respiration, and a stethoscopic determination of no heartbeat was used to confirm death.

A total of 8 piglets were euthanized by barbiturate injection. One piglet was too small for the unit; six were euthanized after 7 minutes (using different flows of N2) because they were unconscious but not dead; 1 piglet recovered movement 30 minutes after being assessed as dead.

Observations and Results

Several iterations of the N2 gas were conducted in order to compare the N2/CO2 gas combination.

The initial nitrogen only study used a high flow rate of N2 gas. In the first trial two small piglets (<1 kg) were euthanized after 7 minutes. In the second trial with nitrogen, one piglet was euthanized after 'death' was determined – it was observed to be moving after placement on the ground one half hour after removal.

Two small trials used 3 litres/min, 4 litres/min and 6 litres/min. These were insufficient flows and piglets were euthanized with barbiturate after 7 minutes. After discussion with

TCC in the Netherlands, the flow rate was adjusted back to 8 litres/minute. The flow rate of N2/CO2 was 1 litre/minute.

Using the N2/CO2 mixture, vocalizations were noted to cease at about 40 seconds. Time to no movement averaged 195 seconds. Piglets < 1 kg averaged 189 seconds to time to no movement. Piglets > 1 kg averaged 195 seconds to time to no movement.

It was difficult to measure cessation of vocalization with N2 only as a number of piglets exhibited rhythmic grunting or 'snoring' for periods of about 60 – 80 seconds. Piglets averaged 210 seconds overall to time to no movement. However, when adjusting for full rate, the time to no movement was 189 seconds; using a flow rate of 8 litres/minute, the time to no movement was 226 seconds. Piglets less than 1 kg averaged 211 seconds to no movement under all N2 gas flows; piglets > 1 kg averaged 210 seconds to no movement under all N2 gas flows. There were too few pigs to produce meaningful averages for weights for 8 litre/minute flows.

At 8 litres/minute N2 flow, piglets averaged 226 seconds to no movement.

Gas	Time to No Movement (All)	Time to No Movement <1 kg	Time to No Movement >1 kg
N2/CO2	195 sec (n=33)	189 sec (n=13)	195 sec (n=20)
N2 full flow	210 sec (n=11)	211 sec (n=4)	210 sec (n=7)
N2 8 l/min*	226 sec (n=9)	--	--

*there were no piglets <1kg in this section of the study

It was noted that piglets made escape attempts ('running' leg movements) when placed into the cone. However, these movements abated as the piglets became sedated from the gases.

It was noted that very small piglets heads folded onto their necks, which could very well compromise respiration during the process. A plastic cap was developed for the unit, with two openings for the hind legs of piglets, which the assessor held during the euthanasia process.

Piglets became unconscious more rapidly under N2/CO2 gas. Piglets ceased moving and vocalizing at around 30 seconds, which is consistent with the literature. However, it was difficult to assess time to no movement/vocalization with the N2 gas as piglets vocalized longer, albeit with a 'snoring' or grunting type of noise as opposed to squealing or other

sounds. Therefore, a comparison could not be made as assessment of unconsciousness was more difficult in the N2 euthanized piglets.

Unfortunately, no cost comparisons were made in this experiment as gas flow levels were adjusted with the N2 flow on the same tanks. With this type of unit design, the higher flow rate of the N2 gas (8 l/min) compared to the 1 litre/min flow of N2/C02 implies that it is more economical to use the combination gas. However, this should be established with further work.

Discussion

Euthanasia methods should minimize pain and distress, and effect a rapid loss of consciousness followed shortly by death. For nursing piglets, common methods of euthanasia are blunt trauma or non-penetrating captive bolt, or gas euthanasia. Gas euthanasia is not uncommonly used on swine farms using either a commercially available unit (Euthanex) or home-built. CO2 is aversive to pigs, and it is recommended that the fill rate for CO2 units be conducted at a rate of about 20% v/v in order to minimize stress.

Nitrogen and carbon dioxide have been tested as a lower-stress alternative gas combination to CO2. It has been proposed that adding CO2 to high nitrogen concentration increases the stability of the gas mixture.[3]

Nitrogen used alone for euthanasia is problematic in that it is lighter than air; a closed chamber has been tested with a prefill that resulted in a 10% oxygen environment prior to placement of piglets (Ecovet). Piglets were observed to vocalize less in this experiment, although gasping and involuntary limb movements were still observed
The N2/CO2 trials were consistent. Piglets lost consciousness (as evidenced by cessation of vocalization) on an average of 40 seconds after placement in the unit. No piglets were euthanized with barbiturate during the combination gas trial.

The use of nitrogen required placing a plastic lid over the cone in an effort to retain gas and reduce any potential of room air dropping into the cone and creating turbulence. Despite some adjustments to the unit (gas flow; plastic cover), seven of seventeen were euthanized over the course of the trial as they were unconscious at the end of seven minutes but were not dead. One piglet was euthanized as it was too small for the unit.

Overall, piglets were observed to become unconscious later with N2 than with the N2/CO2 combination. With the N2 gas, piglets were vocal initially; some grunted periodically up to

about sixty seconds, making it difficult to determine if they were conscious or if this was an unconscious 'snoring' effect. This grunting or 'snoring' had been seen in an earlier trial with N2 gas in a different unit. Despite the use of the cap, piglets became unconscious later than piglets with the N2/CO2 gas.

After using this unit, it was felt that the cones were in and of themselves somewhat stressful to the piglets. Placing them head first created an escape response. Very small piglets would "fold" at the apex of the cone, with their heads bent which was felt to compromise the trachea and ability to breathe the gas mixture. Accordingly, the unit was quickly adapted so that the pig's hind legs could be held as they were breathing the gas.

Despite the poorer results of nitrogen in this study, it should still be explored as a useful gas for euthanasia. A different design for the miniNOFF, as in changing the cones to a chamber, may well result in improved performance of the unit with respect to piglet stress and rapidity of unconsciousness during the process.

References

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