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Assessing the effectiveness of a non-penetrating captive bolt for euthanasia of newborn piglets

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Introduction

Swine producers must inevitably deal with on-farm euthanasia of low viability and compromised piglets. Compromised piglets are of low economic value and may be underweight, weak, malformed, emaciated or have any other condition that will challenge their long term survival. At the present time, carbon dioxide, electrocution, anaesthetic overdose and blunt trauma are all considered appropriate methods for euthanasia of farrowing pigs on-farm (AVMA, 2001). However because of human safety, cost and convenience, blunt trauma is one of the most common methods used. The goal of any euthanasia method must be the humane death of an animal with the minimum of pain, fear or distress (Working Party Report, 1996; AVMA, 2001), but there are other important considerations such as human safety, practicality, complexity of the procedure and cost. Euthanasia procedures should also be aesthetically and emotionally acceptable to those staff members that have the responsibility of performing euthanasia. Currently, manual blunt trauma to the head is suggested for piglets less than 3 weeks of age by both the American Veterinary Medical Association and the American Association of Swine Veterinarians. However, some stockpeople find this method distasteful and may delay performing euthanasia in order to avoid the procedure altogether. In addition, application of blunt trauma methods may lack repeatability and accuracy, especially if a stockperson is not comfortable with the technique or is not strong enough to adequately carry out the procedure. There is currently no suitable method for training barn staff to perform effective blunt trauma. A device that is effective, easy to use and more emotionally acceptable to farrowing house staff would be a valuable alternative to currently available methods.

Recently, a non-penetrating captive bolt device for stunning rabbits was developed using a commercially available pneumatic nailing device with the addition of a hard plastic ball, powered by a portable air compressor (the Zephyr; Rau, unpublished data). Preliminary trials on dead piglets and a small sample (n = 4) of low viability neonatal piglets indicated that when this device was applied perpendicularly to the head of a piglet at an air pressure of 120 PSI, it resulted in severe trauma to the skull and underlying brain tissue and rapid insensibility followed by death in the live piglets.

The objective of this study was to evaluate the effectiveness of this non-penetrating captive bolt device in comparison to traditional methods for on-farm euthanasia of low viability neonatal pigs when performed by different stockpeople.

Methods

Six southwestern Ontario commercial farms and the University of Guelph swine research farm were provided with a Zephyr, a portable air compressor and approximately one hour of training in the operation and application of the device. Euthanasia was exclusively performed by the farm's employed stockpeople; all were experienced in use of blunt force trauma. Each stockperson selected piglets requiring euthanasia (all less than 24 hours old) and then each piglet was randomly assigned one of the euthanasia methods. All stockpeople performed euthanasia using either manual blunt trauma (BT) or the Zephyr (ZE), except the University research farm where standard operating protocols indicate intracardiac injection with Euthansol in place of blunt trauma. In total, nine stockpeople euthanized 99 low viability piglets using the Zephyr (ZE) and 76 piglets using traditional manual blunt trauma (BT).

Non-penetrating captive bolt

The piglet was positioned in sternal recumbancy on a flat, hard surface such as a cement floor or immobile work bench. The piglet was held with the stockperson's finger tips at the base of the ears and the palm of the hand stabilizing the shoulders. With the air compressor already charged to 120 psi, the barrel of the Zephyr was then placed with gentle pressure on the forehead area of the piglet's head. The trigger was depressed. The operator then positioned the barrel of the Zephyr between the ears so that the bolt was directed toward the piglet's nose. The trigger was depressed. The entire process took less than 5 seconds to perform.

Blunt trauma

Manual blunt trauma was applied by grasping the rear legs of the piglet and striking the top of the cranium firmly and deliberately against a flat, hard surface.

On farm measurements

An observer travelled to the farm to record observations and to collect the piglets for later examination. The observer

was blinded to the euthanasia method by moving out of sight during the procedure. Immediately after the euthanasia procedure was performed the observer returned and systematically recorded any signs of return-to-sensibility which included palpating the cornea for a blinking reflex, presence of a fixed central eye position and the absence of jaw tone. Also recorded were presence of respiration and duration of limb reflex movements by visual inspection and heartbeat by palpation and stethoscope. If at anytime the piglet appeared to be returning to sensibility as indicated by the return of reflexes or breathing, data recording was terminated, the euthanasia method was repeated immediately, and insensibility was confirmed.

Post-mortem examinations

The piglets' carcasses were transported to the university lab and frozen. Prior to post-mortem examinations, piglets were thawed for 24 hours. Post-mortem examinations included visual inspection of the head for broken skin. The skin was then removed from the forehead region and the amount of subcutaneous haemorrhaging and skull fracture was scored on a 5 point scale. The skull was then removed and the amount of subdural haemorrhaging was also graded on the same scale as the previous two measurements.

Statistical analysis

All measurements were analyzed using the Proc GLM procedure for SAS.

Piglets that showed signs of return-to-sensibility (Table 1) were not used in the analyses.

Results

Piglets euthanized by ZE had a longer duration of leg movement (124.60 ± 11.25 vs. 68.40 ± 7.14; $P = 0.004$) and heartbeat (408.65 ± 38.82 vs. 170.91 ± 18.43; $P < 0.0001$). Subcutaneous and subdural haemorrhage scores were also higher for ZE (3.56 ± 0.14 vs. 2.46 ± 0.15 and 3.51 ± 0.14 vs. 2.52 ± 0.17 respectively; $P < 0.0001$) (Table 2).

Farm 5 piglets had a longer mean duration of leg movement when the Zephyr was used than any other farm using either blunt trauma or the Zephyr ($P < 0.0971$). Differences between farms was also found in mean duration of heartbeat where piglets euthanized by ZE on Farm 4 took longer for their heart to stop than all other farms ($P < 0.0222$). In addition, Farms 6 and 7 had a shorter mean duration of heartbeat when using the Zephyr compared to farms 2, 3 and 5 using the same method ($P < 0.0377$) (Figure 1).

Skull Fracture Score was lower for Farm 5 than farms 1, 2, 4 and 6 ($P < 0.0063$) (Figure 2). Furthermore, Skull Fracture score was also lower for stockperson Kr when piglets were euthanized by blunt trauma than all other stockpeople for both blunt trauma and Zephyr ($P < 0.006$) (Figure 3).

Subdural Hemorrhage Score for Farm 7 was lower than farms 2, 4 and 5 ($P < 0.0379$) (Figure 2).

Over the course of data collection it became apparent that some farms (or Zephyr guns) were performing more poorly than others. Therefore the calibration and repeatability of the guns was tested. Each of the Zephyr guns was tested for repeatability by firing them 10 individual times into

Table 1: Total number of piglets euthanized per stockperson (Total), number of pigs to show signs of return-to-sensibility after euthanasia method was performed (Return) and total number of pigs used in statistical analysis (Analyzed) per treatment.

		Blunt trauma			Zephyr		
Farm	Stockperson	Total	Return	Analyzed	Total	Return	Analyzed
1	M	10	0	10	10	0	10
1	C	2	0	2	2	0	2
1	K	6	0	6	7	0	7
2	J	10	0	10	10	1	9
3	N	n/a	n/a	n/a	11	1	10
3	V	n/a	n/a	n/a	8	2	6
4	T	10	0	10	10	4	6
5	Kr	9	0	9	10	5	5
5	R	9	0	9	11	0	11
6	S	10	0	10	10	0	10
7	Co	10	0	10	10	0	10
Total		**76**	**0**	**76**	**99**	**13**	**86**

plasticine moulds. The same air compressor was used for each gun and was allowed to charge fully to 120 psi between each firing. The depth and diameter of the depression were measured to the millimetre.

The calibration trials revealed that within Gun, the firings were highly consistent but that Gun 1 had greater average depth of penetration than Guns 2 and 3 (8.40 ± 0.16 vs. 7.10 ± 0.12 and 6.65 ± 0.27; $P < 0.0001$) and all Guns were different in diameter than each other (23.7 ± 0.15 vs. 24.15 ± 0.18 vs. 23.15 ± 0.08 for Guns 1, 2 and 3 respectively; $P < 0.0366$). Unfortunately, we were unable to match which gun was used on each farm.

Discussion

The goal of any euthanasia method must be the humane death of an animal with the minimum of pain, fear or

Table 2: Mean (± SEM) and p values for treatment effects

Variable	Zephyr	Blunt trauma	*P* Value
Leg movement (sec)	124.60 ± 11.25	68.40 ± 7.14	0.0004
Heart beat (sec)	408.65 ± 38.82	170.91 ± 18.43	< 0.0001
Weight (kg)	0.78 ± 0.04	0.74 ± 0.04	0.7556
Length (cm)	26.44 ± 0.35	26.25 ± 0.40	0.9433
Subcutaneous score	3.56 ± 0.14	2.46 ± 0.15	< 0.0001
Skull fracture score	3.20 ± 0.11	3.00 ± 0.16	0.4865
Subdural score	3.51 ± 0.14	2.52 ± 0.17	< 0.0001

Figure 1: Mean duration of Leg Movement and Heartbeat for each farm where Farm 5 had a longer duration of Leg movement for ZE than all other farms ($P < 0.0971$) and Farm 4 had a longer duration of heartbeat for ZE ($P < 0.0222$) than all other farms. Farms 6 and 7 had shorter durations of heartbeat for ZE (0.0377) than farms 2, 3 and 5.

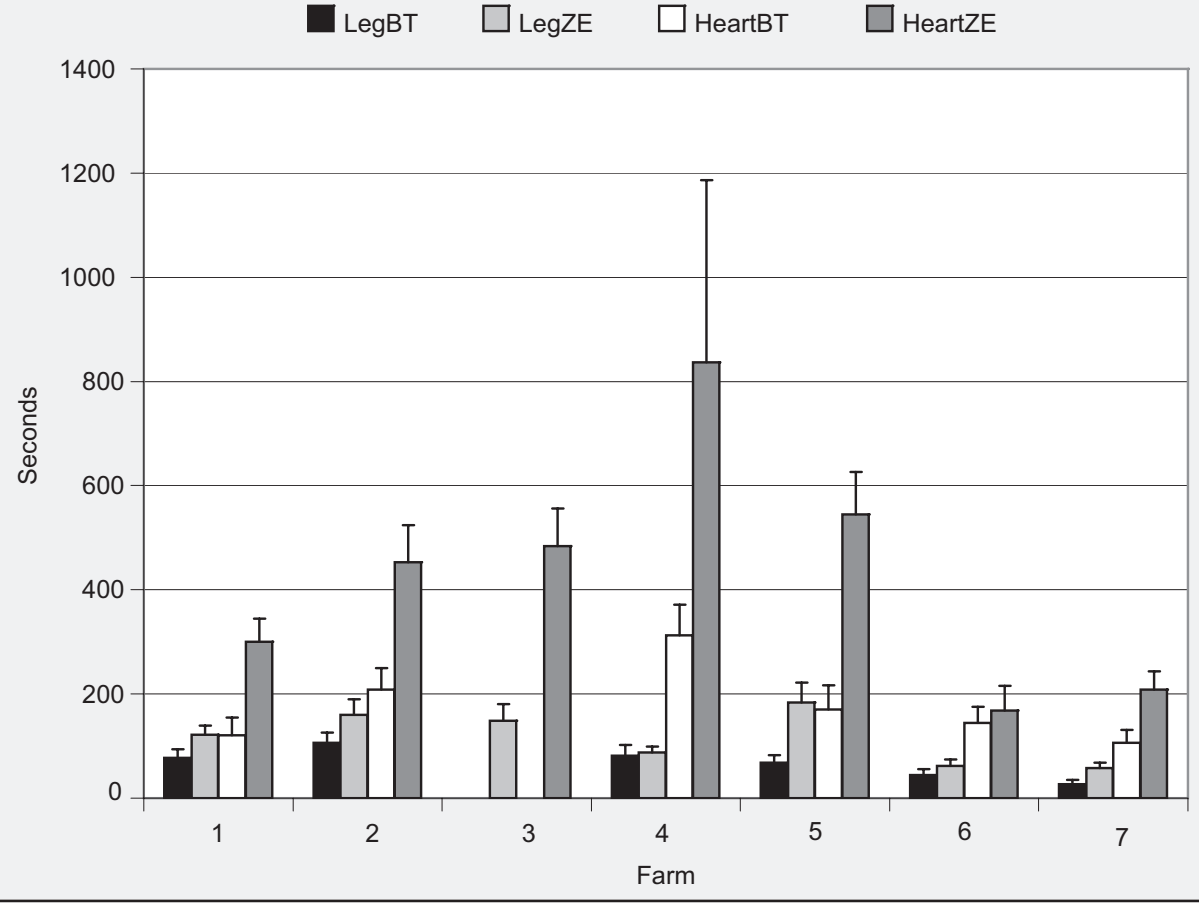


Figure 2: Mean Skull Fracture and Subdural Hemorrhage Score where Farm 5 had a lower Skull score than farms 1, 2, 4 and 6 ($P < 0.0063$) and Farm 7 had a lower Subdural score than farms 2, 4 and 5 ($P < 0.0379$).

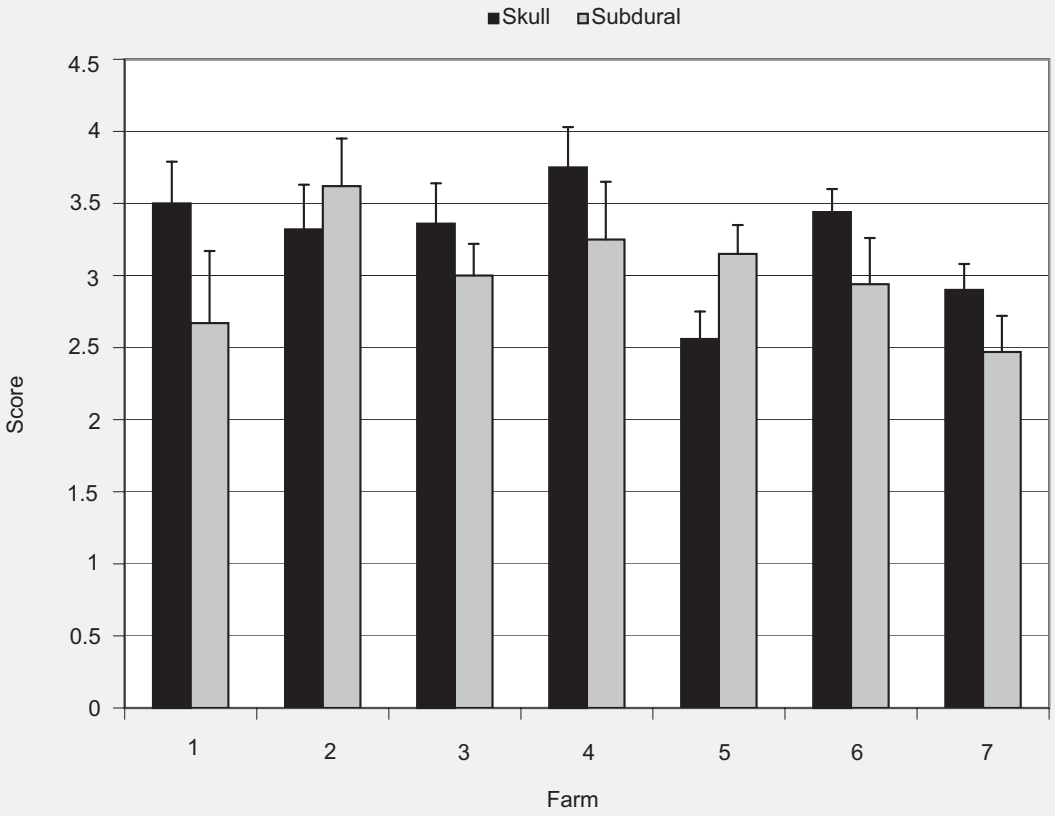
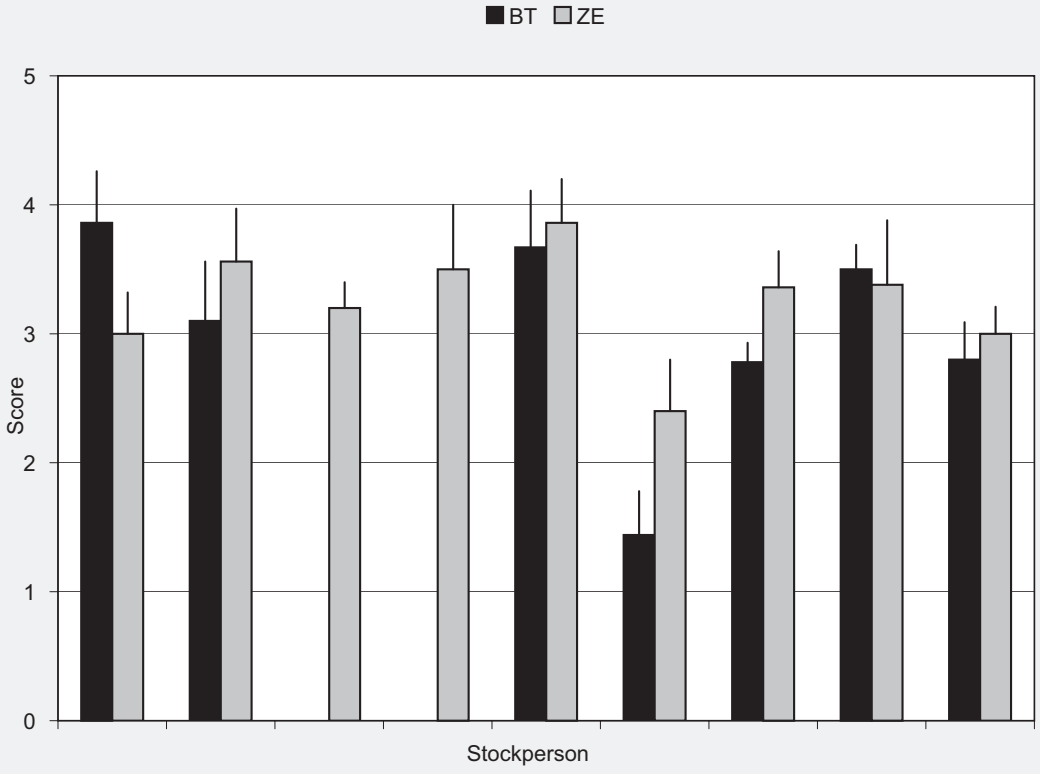


Figure 3: Mean Skull Fracture Score where BT for Kr differed from all others ($P < 0.006$).



distress. Currently, the AVMA and AASV recommend manual blunt trauma as an option for humane euthanasia of piglets under 3 weeks of age. However it is sometimes suggested that because the success of this method is dependent on the force the stockperson exerts, it can lack repeatability and accuracy. It is also aesthetically unpleasing which may result in delayed euthanasia of compromised piglets.

The results from this trial indicated that manual blunt trauma was a rapid, effective and humane method of euthanizing low viability piglets. Seven different stockpeople performed the procedure on a total of 76 piglets; all piglets were rendered insensible and none showed signs of return to sensibility. Heart beat ceased in less than 3 minutes. There was some variability in the degree of head trauma from one stockperson to another but this did not influence to cessation of movement or heart beat.

Effectiveness of the Zephyr was variable from farm to farm. Some piglets began to show signs-of-return to sensibility. Cessation of leg movement and heart beat took significantly longer compared to manual blunt force trauma. This may be explained by the variability found between Zephyr guns. However, once the variability of the Zephyr device was adjusted and standardized the effectiveness improved in the last two farms tested (Farms 6 and 7).

At present, this non-penetrating captive bolt device is not a consistent enough method for euthanizing low viability piglets. Before the Zephyr can be recommended as a humane option for commercial application, further modification to training, technique and the apparatus are required.

Acknowledgements

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