**Humane euthanasia of neonates I: validation of the effectiveness of the Zephyr EXL non-penetrating captive-bolt euthanasia system on neonate piglets up to 10.9 kg live-weight**

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**Abstract**

To determine if mechanical blunt force trauma using a non-penetrating captive bolt was a viable method of producing an immediate stun/kill in neonate piglets (*Sus scrofa domesticus*) as an alternative to manual blunt force trauma. Piglets (n = 60) were acquired from a local producer and allocated to one of five weight ranges: birth weight to 3 kg (n = 12); 3 to 5 kg (n = 11); 5 to 7 kg (n = 13); 7 to 9 kg (n = 13); and 9 to 11 kg (n = 11). These piglets with an average live-weight of 6.1 kg were anaesthetised and electroencephalogram (EEG) recording electrodes inserted sub-dermally over the right cranium to allow recording of Visual Evoked Potentials (VEPs). Following recording of baseline VEPs in the anaesthetised state, the piglet was shot once in the frontal-parietal position with a Bock Industries Zephyr EXL non-penetrating captive bolt powered by 120 psi air pressure. Movement scoring, behavioural indices of loss of brain function and VEPs were monitored throughout. VEPs were lost immediately in all piglets shot when the head was resting on a hard surface. This experiment demonstrates that mechanical blunt-force trauma, using a single-shot, non-penetrating captive bolt, such as the Zephyr EXL, provides for an immediate stun kill in neonate piglets up to 10.9 kg live-weight. This immediacy of action, combined with reproducible effects will improve the welfare of piglets to be subjected to on-farm euthanasia due to disease, ill-thrift or other commercial concerns.

**Keywords**: animal welfare, captive bolt, euthanasia, mechanical stunning, piglet, Visual Evoked Potentials

**Introduction**

Modern pig (*Sus scrofa domesticus*) production has an inherent requirement for the humane euthanasia of neonate piglets for various reasons, including herd productivity, disease and under performance. In the United Kingdom, pre-weaning mortality averages 14.18% (Agriculture and Horticulture Development Board Report 2015) indicating that one in twelve piglets in a litter may require dispatch before the average weaning age of 26 days (average piglet weight 7 kg). The traditional method of dispatch is manual blunt-force trauma (MBFT), either through holding the piglet by the hind legs and hitting the head against a hard object or using some form of blunt-force trauma such as a ‘priest’ (a heavy-ended baton also known as a gamekeeper’s or poacher’s priest) or a hammer. Manual blunt-force trauma as a humane method of euthanasia has several issues; firstly, it relies upon the ability of the operator to successfully perform the action, secondly the effects may not be reproducible and, thirdly, stockmen do not like performing the operation unless the animal appears ill and the method of euthanasia was perceived as being less painful to the animal (Matthis 2004; Mort *et al* 2008; Whiting & Marion 2011; Whiting *et al* 2011). Mechanical killing via blunt-force trauma using a non-penetrating captive-bolt device has the advantage of reproducibility, less reliance upon operator ability and with training, including the identification of post mortem movement that indicates an effective stun/kill, enhanced operator acceptability.

Non-penetrative mechanical stunning relies upon imparting kinetic energy to the cranium to produce concussive effects within the brain, based on the velocity of the impact rather than the mass of the object (Daly *et al* 1987). The concussion produced by this impact is often associated with both haemorrhaging at the impact site (‘coup’) and further haemorrhaging opposite the impact site (‘contra-coup’) (Ommaya *et al* 1971). This is due to the rotational and differential acceleration of the brain within the cranium (Ommaya & Gennarelli 1974). Shearing forces are produced within the brain by the pressure waves producing vacuolation (Finnie 1995; Finnie *et al* 2003), disruption of synaptic transmission (Gregory 1998) and depolarisation of neurons away from the impact site (Somjen 2001). Shaw (2002) also discusses the effects of sudden change in intra-cranial volume, brain compression and pressure waves following compression of the skull, with the pressure waves terminating at the brainstem and cranio-cervical junction. The most common