Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

INVESTIGATION OF WELFARE IMPACTS OF GASEOUS METHODS FOR ON-FARM EUTHANASIA OF SUCKLING PIGLETS

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science

In

Physiology

At Massey University, Manawatu,

New Zealand

Nicola Jean Kells

2012

Abstract

Blunt trauma (BT) to the head is the most common method used for on-farm euthanasia of pre-weaned piglets. When performed correctly, loss of consciousness is immediate, but the potential for delivery of sub-lethal blows, along with aesthetic unacceptability to many operators, has lead to the need for alternative methods to be developed.

One recommended alternative is exposure to 100% CO_2. Although gas euthanasia is potentially more reliable and less disturbing to perform than BT, there are concerns that CO_2 may induce breathlessness and pain before loss of consciousness, thus negatively affecting piglet welfare. This research aimed to evaluate the welfare impact of alternative gases, relative to CO_2, for piglet euthanasia.

A small pilot study was conducted to select appropriate gases for further evaluation. This identified 100% argon (Ar) and a mixture of 40% CO_2-60% argon (CO_2-Ar) as possible alternatives to 100% CO_2 (CO_2) for piglet euthanasia.

The relative welfare impacts of CO_2, Ar and CO_2-Ar were evaluated in two studies. These studies aimed to identify the interval following gas exposure in which the animal may be conscious, and to identify evidence of welfare compromise within this interval. Identifying the period of possible consciousness is important in evaluating welfare impact, as this defines the time period in which the animal is capable of perceiving potential negative experiences associated with euthanasia.

In the first study, conscious animals were exposed to the test-gases in a purpose-built chamber. Behavioural and physiological data including escape attempts, vocalisation, loss of coordination, loss of posture, respiratory effort, convulsions, gasping, and respiratory arrest were recorded until death. Loss of posture has previously been used to infer the onset of unconsciousness, whilst escape attempts, vocalisation and laboured breathing are associated with the experience of pain, aversion and distress in animals. Piglet behaviour was examined for evidence of negative experience prior to the onset of unconsciousness.

In the second study, EEG and ECG data were recorded from anaesthetised, immobilised pigs during exposure to the same test gases used in the first study. Changes in the amplitude of the raw EEG can provide information on the level of consciousness. Changes in the EEG power spectrum, derived from mathematical transformation of the raw EEG, can provide evidence of noxious stimulation in anaesthetised mammals. EEG recorded during exposure to test gases was analysed to determine the likely latency to loss of consciousness with each gas, and to determine

whether nociceptive processing occurred. Changes in heart rate, derived from the ECG, are frequently used as indicators of acute stress in mammals. ECG recorded during gas exposure was examined for indications of physiological stress responses.

Behavioural data suggested that the latency to onset of unconsciousness did not differ between gases. However, the changes in the amplitude of the EEG suggested that loss of consciousness may occur sooner with CO_2 than with Ar or CO_2-Ar. Behavioural data indicated that piglets found CO_2 exposure more aversive or unpleasant than exposure to either Ar or CO_2-Ar. However, CO_2-Ar induced greater respiratory stimulation than Ar alone, suggesting that Ar caused the least negative welfare impact of the 3 gases. ECG data showed that heart rate increased prior to likely loss of consciousness in piglets exposed to CO_2 and CO_2-Ar but not Ar alone, suggesting that Ar exposure does not induce a physiological stress response.

Contrary to expectations, there was no evidence of nociception in piglets exposed to either 40 or 100% CO_2, although this may have been influenced by the method used.

Together, these data suggest that whilst CO_2 induces more rapid loss of consciousness than Ar, it also results in significantly greater welfare impact prior to loss of consciousness. The addition of CO_2 to Ar may provide some welfare advantage over CO_2 alone, but not over Ar alone. From a welfare perspective, Ar is preferable to either CO_2 or CO_2-Ar for piglet euthanasia.

Acknowledgements

I would like to thank a number of people, whose input, guidance and support were integral to the successful completion of this work.

To my supervisors, Dr. Ngaio Beausoleil, Dr. Mhairi Sutherland and Associate Professor Craig Johnson: Thank you so much for the knowledge and expertise you have shared, the assistance and encouragement you have given and for the confidence you have instilled in me.

To Amanda McIlhone, thank you for your practical assistance with all aspects of the study and particularly for your invaluable help with the analysis and interpretation of EEG data.

To Antony Jacob, thanks for your assistance with the handling of animals throughout this study.

To Neil Ward, your help with the technical aspects of this study was much appreciated.

I would like to acknowledge the US National Pork Board and the IVABS post-graduate research fund for their assistance in funding this body of work.

To my mother and late father: Thank you for always being there, for your enduring love, support and encouragement, and for inspiring me to be a better person.

To my daughters, Tayla and Samara: Thank you for being such amazing, awesome people, for being so patient and understanding and for being so proud of me.

Table of Contents

List of figures

List of Tables

Commonly used abbreviations

BT	Blunt trauma
CO_2	Carbon dioxide
ECG	Electrocardiogram / electrocardiographic
EEG	Electroencephalogram / electroencephalographic
N_2	Nitrogen
pCO_2	Partial pressure of carbon dioxide
pO_2	Partial pressure of oxygen
SEM	Standard error of the mean

Explanation of terms as applied in this document

Dyspnoea	The subjective experience of breathing discomfort, incorporating sensations such as the uncomfortable awareness of breathing, the sensation of breathlessness or the experience of air hunger
Hypercapnia	State in which arterial pCO_2 rises above the normocapnic range
Hyperventilation	Increase in ventilatory rate above normal resting values
Hypoxic	State in which arterial pO_2 falls below the normoxic range
Nociception	Neural process of encoding and processing noxious stimuli
Nociceptor	Sensory receptor that is activated by noxious stimuli, which then sends neural signals to the spinal cord and brain
Normocapnic	Within the normal arterial pCO_2 range of 36–44 mmHg
Normoxic	Within the normal arterial pO_2 range of 80–100 mmHg
Noxious stimulus	Stimulus that is damaging, or threatens damage, to normal tissues
Pain	Unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage
Respiration	Synonymous with ventilation; respiration rate thus refers to the number of breaths per minute
Ventilation	The process of filling and emptying the lungs with air, or breathing