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A note on variations in pig blood temperature measured at exsanguination

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Abstract

This study investigated the temperature of pigs' blood as it flowed from the sticking wound at exsanguination using infra-red thermometry and how it might reflect changes in core body temperature. A total of 417 pigs were monitored over a three-day period, which included a subset of 206 pigs for which additional information concerning transport conditions and ambient temperature was also known. The range of blood temperatures recorded was large (35.6–43.2°C) with a significant number of the animals found to have blood temperatures above the pigs' normal temperature (39 ± 1°C). Within the subset of pigs, average blood temperature of all the pigs in a pen at slaughter appeared to be related to pen temperatures and position on the lorry and was sensitive enough to detect changes in environmental ambient conditions.

Keywords: *animal welfare, blood temperature, core temperature, environmental conditions, pigs, transport*

Introduction

Body temperature is a critical aspect of an animal's thermal equilibrium and has been used as a measure of heat stress and health in many experiments (Lefcourt & Adams 1996; Ingram *et al* 2000). High ambient temperature has been associated with increased mortality in pigs being transported to slaughter with well defined seasonal effects showing more pigs dying during the summer months (Lendfers 1970; Allen & Smith 1974; Fabiansson *et al* 1979; Warriss & Brown 1994). It is possible that these high ambient temperatures could be associated with elevated core temperatures in some animals, possibly indicating severe heat stress. Therefore, a method that might signify changes to the core temperature of pigs could be a useful measure of welfare. Skin, ear and rectal temperatures have been used to indicate core temperature (Knowles *et al* 1998) but many researchers agree that the best estimate of core temperature is achieved by measuring the temperature of the blood flowing in major arteries near the heart (Parrott *et al* 1999; Hanneman *et al* 2004; Shipp *et al* 2004). Access to these vessels, while the animal is alive, is not easy and would require an invasive operation. However, during the slaughter process pigs have the major heart blood vessels within the brachiocephalic trunk cut (sticking) within a few seconds after stunning. The initial flow of blood from the sticking wound could therefore provide an accurate estimate of deep core temperature. This study surveyed changes in the temperature of the initial flow of blood at exsanguination in slaughter pigs.

Materials and methods

A total of 417 pigs were assessed at a commercial abattoir in the United Kingdom and blood temperature measured. For a subset of 206 pigs extra details were recorded such as pen position and pen environmental temperature using loggers suspended just above pig head height (Gemini Tinytalk® Ultra data loggers, Chichester, UK) on the lorry during transport, as well as an estimate of environmental temperature measured several times during the day with a digital thermometer (Comark Ltd, Stevenage, UK). All the pigs assessed were subjected to normal commercial handling including being mixed pre-slaughter. They were transported approximately the same distance to the slaughter plant but were held in the lairage in the same groups as they were on the lorry (approximately n = 14) for about one hour before slaughter. They were not sprayed with water. The sampling took placed on three days over a two-week period during the summer of 2003.

The pigs were killed using CO_2 and exited the stunner in the prone position where they were stuck and exsanguinated within 5 seconds. The animals remained prone for a total of approximately 40 seconds before they were hung on to the overhead dressing rail. During exsanguination the blood temperature of each pig was measured as quickly as possible (within approximately 2 seconds of sticking), in the flow of blood exiting the sticking wound, using a Raytech PM® non-contact infra-red thermometer (Raytech Inc, Bletchley, UK). The infra-red thermometer was directed

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accurately to the centre of the blood flow using a visible laser marker which produced a spot of light at the point of measurement.

Significant differences between pen and day means were tested using a one way ANOVA.

Results and discussion

Homoeothermic animals are able to maintain a near constant body temperature by balancing heat generated and heat lost. The goal of thermoregulation is to maintain a constant deep-body temperature (core temperature) and to prevent hyperthermia (overheating) and hypothermia (overcooling). Hyperthermia is a major problem in pigs as they are only able to tolerate very small increases (3-5°C) (Lambooij & van Putten 1993) in core temperature before death is likely to occur but can tolerate a relatively larger decrease (10°C).

Using the data from the survey of 417 animals the distribution of blood temperatures is shown in Figure 1. Normal blood temperature for resting pigs is 39 (± 1)°C (Blood *et al* 1983) however temperatures as high as 41.5°C have been recorded in animals subjected to high environmental temperatures, severe exercise or mixing (Blood *et al* 1983; de Jong *et al* 1999). The combined data indicate that 40% of the animals surveyed had elevated blood temperatures. These may be the result of stress induced hyperthermia (SIH) during handling or heat stress during transport to slaughter where animals are held in enclosed pens at relatively high stocking densities on lorries. SIH results in an increase in body temperature thought to be influenced by prostaglandins released by the central nervous system (Kluger *et al* 1987; Parrott & Lloyd 1995) and can last up to 8 h in some animals. This condition is known to occur when pigs are mixed or handled poorly (de Jong 1999) which occurs frequently with slaughter pigs. Heat stress is less likely to occur during transport, while the lorry is moving, when the air-flow is probably sufficient to allow the animals to be cooled by radiation and convection. However, once the lorry stops, the temperature of the air in the pens rises very quickly (Grandin 2002). With a lack of air flow, cooling by radiation and convection can be severely impaired and the pig's core temperature can quickly increase to an extent that may cause distress and, in extreme circumstances, possible death from heat stress (Lambooij & van Putten 1993). Of course death is a severe insult to the animal's welfare and easy to assess but many animals may have elevated core temperatures which, although insufficient to result in death, will nonetheless compromise welfare.

Pigs that were surveyed and had both the environmental conditions during transport and pen position on the lorry recorded, showed a good correlation between the average blood temperature at slaughter of all the pigs in a pen and average lorry pen environmental temperature recorded during transport for the three trial days (Figure 2, $R^2 = 0.61$). Further analysis (Figure 3) indicates that average blood temperatures of all the pigs in the pen at slaughter were also influenced by external ambient temperature and position of the pen on the lorry. The average blood temperature of all the pigs in a pen at slaughter transported in pen 1 immediately behind the cab was approximately 2°C warmer than that observed in pigs transported in pens at the back of the lorry (pen 5); (pen 1 = 38.5°C, pen 5 = 40.4°C; $F = 14$, $P \leq 0.001$). This may be the result of an additive effect of both increased air temperature in the pen and SIH. The pen immediately behind the cab is known to be more stressful for animals, as indicated by increased levels of cortisol (Meat and Livestock Commission 1993; Warriss *et al* 2006). Overall, ambient temperature had an additive effect on blood temperature, with warmer days increasing blood temperature (day 1 = 40.7°C, day 2 = 38.7°C, day 3 = 39.0°C; $F = 64$, $P \leq 0.001$) (Figure 3). The external environmental temperature conditions in this trial were not particularly high and it could be envisaged that, with a combination of transport, handling, mixing and hotter days, many more animals could have elevated core temperatures.

The raised pig blood temperatures observed at slaughter indicate that recovery from elevated core temperatures can take several hours since higher than normal blood temperatures were recorded even after one hour of rest in the lairage. The use of water sprays in lairage (Knowles *et al* 1998) may assist the cooling of pigs by evaporation, but they were not used in this trial.

In summary, blood temperature measured at exsanguination using infra-red thermometry indicates that a significant number of the animals assessed had elevated core temperatures above normal values even though ambient temperatures were not particularly high and transport and handling conditions were not that severe.

Animal welfare implications

Blood temperature could be used under commercial conditions to monitor changes in the core body temperature of pigs which could then be used as a welfare index. Although the measurement would be carried out after the animals had been subjected to heat stress it could allow slaughter plants to identify, in their own particular situation, combinations of conditions, handling, mixing, environmental and transport which lead to elevated core temperatures and a lower welfare index. Measures could then be taken to avoid potentially stressful conditions. However, when they do occur, ideally the animals should be killed immediately, but this is frequently not possible under commercial conditions and alternative systems need to be in place to ensure that the animals are cooled, rested and welfare is maintained.

This study has identified a simple method which, although available only under slaughterhouse conditions due to the requirement for blood from the major blood vessels, could still be a useful tool for monitoring animal welfare. It might be sensitive enough to examine more specific handling and transport regimes and may also be applicable to other species especially sheep, which frequently travel long distances in very hot weather and at quite high stocking densities.

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Figure 1

The distribution of blood temperature at slaughter (n = 417).

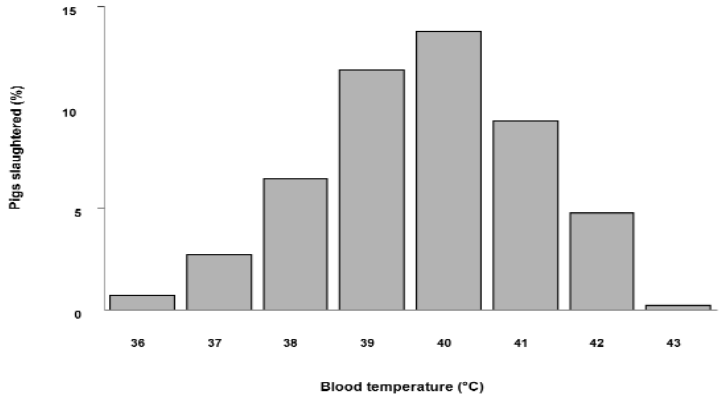


Figure 2

Relationship between average pen temperature on the lorry during transport and average blood temperature of all the pigs in a pen at slaughter (15 pens, n = 206, approximately 14 pigs per pen). Each point is the mean (± SE).

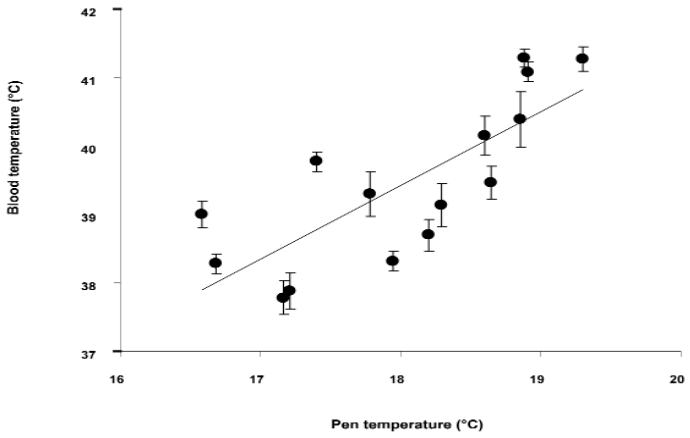
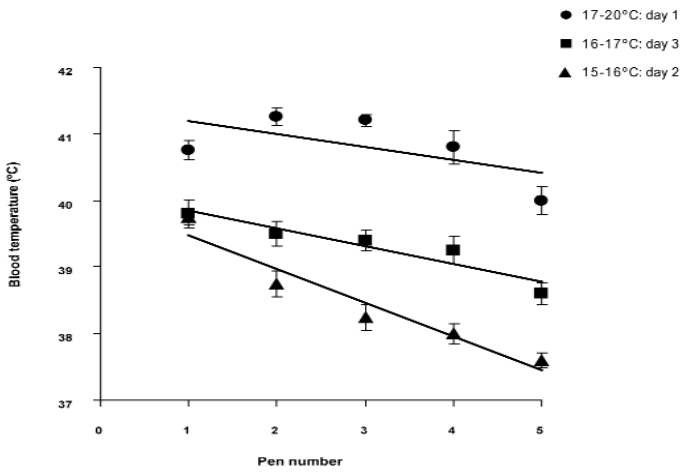


Figure 3

Effect of ambient temperature and pen position on the lorry on average blood temperature of all the pigs in a pen at slaughter (1 cab–5 back of lorry, 15 pens, n = 206, approximately 14 pigs per pen). Each point is the mean (± SE).



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