Caffeine increases an neonatal piglets body temperature and negatively affects survival at 24 hours of age

T.L. Nowland¹, B. Dearlove¹, K. Kind¹ and W. van Wettere¹

¹School of Animal and Veterinary Sciences, University of Adelaide, Roseworthy SA 5371 Australia
Presenting author: Tanya Nowland tanya.nowland@sa.gov.au

Summary

Piglet pre-weaning mortality is a major economic and welfare concern. Caffeine administration prior to, or after, parturition positively affects metabolic parameters associated with neonatal survival. However, the impact of dosing piglets with caffeine at varied time points within 24 hours of birth on temperature and survival to post-natal day 20 (weaning) has not yet been evaluated. Piglets received caffeine orally at birth and 24 hours post-partum or 8-12 hours and 24 hours post-partum. Body temperature was collected 10 minutes, 24 and 72 hours after birth and mortality recorded to post-natal day 20. Regardless of timing of administration, caffeine increased piglet body temperature 24 and 72 hours post-partum (P<0.05). Piglet mortality within 24 hours post-partum was higher (P<0.05) for the caffeine at birth treatment group (8.5%) compared to all other treatment groups (range: 2.5% - 3.5%). Although caffeine positively affected thermoregulation, survival of piglets receiving caffeine at birth was reduced.

Introduction

Within the Australian pig industry, approximately 710,500 live born piglets (11.3%) die each year prior to weaning (Australian Pork Limited 2013). This high rate of pre-weaning piglet mortality represents a major economic and welfare concern to the industry (Deroth and Downie 1976). Pre- and peri-partum causes of piglet death include: large litter sizes and long parturition times, placental detachment, and umbilical cord occlusions, ruptures or breaks (Alonso-Spilsbury et al. 2005; Borges et al. 2005). These factors decrease blood flow and oxygen delivery to the fetus during parturition, leading to hypoxia, which commonly results in stillbirths or low viability piglets (Son et al. 2014). Caffeine administration prior to, or after, parturition positively affects metabolic parameters associated with survival in newborn animals and can reduce the negative effects of hypoxia (Orozco-Gregorio et al. 2011). However, its effect on piglet body temperature during the first three days of life, and survival to 20 d of age when given at varied times within the first 24 h of life has not been evaluated. It was hypothesised that orally dosing piglets with caffeine either at birth and 24 h of age or 8-12 and 24 h of age would increase survival of piglets, and improve regulation of body temperature.

Materials and Methods

A total of 634 piglets were studied. The four treatments administered were caffeine at birth (n = 129), control solution at birth (n = 118), caffeine 8 – 12 h post-partum (n = 203) and control solution 8 – 12 h post-partum (n = 184). Treatments were randomly allocated within each sow’s litter prior to farrowing, and were distributed evenly across birthing order. Caffeine (30 mg) was dissolved in 2 ml of water. Control solution was 2 ml of water. Treatments were administered orally using a piglet applicator gun. The caffeine at birth (Caff) and control at birth (Con) groups received 30 mg caffeine (Caff) or 2 ml of water (Con) at birth and at 24 h. After treatment at birth, piglets were placed near their mother’s vulva to imitate where they were born. The caffeine eight-hour treatment group (Caff8) and control eight-hour treatment group (Con8) received 30 mg of caffeine (Caff8) or 2 ml of water (Con8) at 8-12 h and at 24 h of age. If a sow farrowed overnight, all piglets in that litter were randomly allocated to either Caff8 or Con8.

Piglets were individually identified at birth using ear tags. Ten minutes, 24 and 72 h post-partum body temperature was recorded. Any deaths occurring prior to 20 d of age were recorded and the cause noted.

Results

Piglet mortality

There was no significant effect of treatment on total piglet mortality between birth and day 20, 24 hours and day three, or days three and 20 post-partum (Table 1). However, dosing piglets with caffeine at birth increased mortalities within the first 24 h after birth compared with all other treatment groups (P = 0.04, Table 1).

Table 1. Percentage of mortalities that occurred within each treatment group at different time points in piglets in four treatment groups: control (Con), control 8 hours (Con8), caffeine (Caff), caffeine 8 hours (Caff8) (n (total deaths) = 65)

<table>
<thead>
<tr>
<th>Piglet mortality</th>
<th>Treatment</th>
<th>Con</th>
<th>Con8</th>
<th>Caff</th>
<th>Caff8</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth – 24 h post-partum</td>
<td>2.5%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.7%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.5%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.5%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>24 h and day 3 post-partum</td>
<td>2.6%</td>
<td>1.7%</td>
<td>6.8%</td>
<td>3.6%</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Days 3 and 20 post-partum</td>
<td>3.6%</td>
<td>4.0%</td>
<td>0.9%</td>
<td>3.2%</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Birth and day 20 post-partum</td>
<td>8.5%</td>
<td>8.2%</td>
<td>15.5%</td>
<td>9.9%</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

Values in the same row with different superscripts differ significantly (p < 0.05)

ASAP Animal Production 2016, Adelaide
**Temperature Characteristics**

At 24 h of age, rectal temperature was higher for piglets in the Caff8 compared with all other treatment groups (P < 0.05, Figure 1). At three days of age, rectal temperature was higher for piglets in Caff compared with the Con and Con8 treatments (P < 0.05, Figure 1).

**Discussion**

The increased mortality of piglets receiving caffeine at birth was unexpected, as previous studies have reported no adverse effects on survival following caffeine supplementation pre- or post-natally. This high mortality in the piglets treated with caffeine at birth may be attributed to piglets being born with low body energy stores and no serum immunoglobulins (IgG) (Le Dividich et al. 2011; Baxter et al. 2008; Rootwelt et al. 2012). Consequently, piglets rely on their ability to reach a teat to obtain colostrum for energy and immune protection (Herpin et al. 1996; Baxter et al. 2008; Rootwelt et al. 2012). Further, caffeine influences catecholamines, which are known to increase energy availability and utilization (Orozco-Gregorio et al. 2012; Superchi et al. 2013). Both of these factors would positively influence animals with abundant energy stores, as it would result in hyperactivity, which may enable them to reach a teat and attain antibodies and energy faster. This was not, however, the case for the piglets treated with caffeine in this experiment.

Caffeine can increase body temperature via its interaction with the purinergic system and other central neurotransmitters and neuromodulators involved in thermoregulation (Superchi et al. 2013). As a result, caffeine would be assumed to elevate body temperature while present within the body, however it would have no lasting effect once metabolised and excreted. This may explain the increase in body temperature recorded 24 h after birth. As the half-life of caffeine in humans is 2.5-10 hours (Orozco-Gregorio et al. 2011) the likelihood of caffeine being present at 24 h in piglets treated with caffeine at birth is low, however, it is likely that caffeine would still be present in piglets given caffeine at 8-12 h.

Interestingly, rectal temperature was higher at three days of age in piglets treated with caffeine at birth but not in piglets treated with caffeine at 8-12 h. It is unlikely that caffeine would still be present in the piglets’ system 48 hours after administration. As both groups of piglets received a second dose of caffeine at 24 h of age, if caffeine were still present, both caffeine treated groups should have demonstrated a similar elevation in body temperature at 3 d of age. This increase in body temperature at 3 d may be explained by the fact that mortality was highest in the caffeine at birth treatment group within the first 24 hours of life. It can be assumed that those that died were low viability or low weight animals. As a result, the average body temperature for this group may be higher due to fewer low viability animals in this group compared to other groups. Ultimately, more research is required in order to establish the full extent to which caffeine influences the body temperature of piglets.

We conclude that caffeine’s effect on energy expenditure, adversely effects those that do not have enough body energy stores to withstand it. Further research on caffeine dosage and timing post-partum is required to establish its efficacy.

**Acknowledgments**

The authors acknowledge the Ronald J Lienert Memorial Scholarship, Australian Pork Limited Scholarship and the University of Adelaide and Roseworthy Piggery for the use of its funding, animals and facilities. Jemma Seyfang, Kate Plush, Cameron Ralph and Patricia Condous for all of their expert technical assistance.

**References**